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The Impact of a Short-Term Review Treatment Program on Student Success in a College Algebra Course

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The Impact of a Short-Term Review Treatment Program
on Student Success in a College Algebra Course

by

Frances Clementi Hopf

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
Department of Adult, Career and Higher Education
College of Education
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MyMathTest, Math Success

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ABSTRACT

The main purpose of this study was to investigate whether conducting a short-term online review of college algebra prerequisite skills at the start of a college algebra course concurrently with the normal course instruction and assignments would have a significant influence on student success. When failure rates in an entry-level college course such as college algebra can range from 20% to 60% or higher, it could present problems for the student and the institution (Burd & Boser, 2009). Research indicates that students who cannot pass entry-level college math courses have decreased chances of obtaining a college degree and it can limit the students' course of study (Adelman, 1999; Thiel, Peterman, & Brown, 2008). While several factors have been found to influence college algebra success, such as instructional practices, students' attitudes toward mathematics, and level of math anxiety, a secondary purpose of this study investigated whether students' gender and number of prior attempts at taking a college algebra course were factors that might interact with student performance.

A quantitative study was conducted in the researcher's college algebra class at the University of South Florida in the fall semester 2010. The design included a treatment group and control group; participants in both were given a pretest and posttest before and after the 4-week treatment period, and all participants took the required departmental final exam. Of the original 187 participants in the study, the final statistical analyses were computed using data from the 165 students who completed the pretest, posttest, and final

exam. Participants who were randomly assigned to the treatment group received an online review of college algebra prerequisite skills using the program, MyMathTest (Pearson Education, n.d.b), which included interactive instruction and practice with a minimum requirement of 3 hours per week for the 4-week treatment period; participants who were randomly assigned to the control group received an alternative assignment based upon their college algebra coursework using the online program, MyLabsPlus (Pearson Education, n.d.a) that accompanied the class textbook, with a comparable weekly time requirement. After the four-week treatment period, the remaining 11 weeks consisted of the normal course of study and concluded with a comprehensive departmental final exam not prepared by the course instructor.

No significant differences in achievement on the final exam were found between the two groups. Also, there were no interaction effects and no main effects for gender and performance on the final exam. Number of prior attempts at college algebra similarly had no impact upon final exam. However, student achievement in the researcher's class was observed to be higher than that found in the other college algebra classes in the department (i.e. the researcher's students performed higher on the departmental final exam and had a lower failure rate than the overall departmental failure rate).

The fact the researcher's college algebra students had greater success when compared to the other college algebra students would suggest other possibilities for future regard. For example, studies comparing use of alternative instructional strategies and/or grading practices may reveal factors that influence college algebra performance. Investigations comparing alternative placement procedures and/or advising strategies might also contribute findings helpful to promoting student success in college algebra.

CHAPTER 1: INTRODUCTION

Problem

High failure rates ranging from 40% to 60% in college algebra since the 1980s have caused concern among the academic community (Burd & Boser, 2009; Stone, 1995; Toubassi, 1991). Failure in college algebra will likely limit a student's course of study because it is a prerequisite for several majors (Thiel, Peterman, & Brown, 2008). To ensure that a greater number of incoming college students are prepared to pass college-level math courses, the states of Florida, Georgia, California, and Maryland are among those that have created coalitions to oversee K-16 policies for math curricula (Kirst & Bracco, 2004). Although these efforts are underway, they do not help present-day college students because considerable time is needed for policy implementation and testing, so there is an immediate need to improve the success rates of the present-day college algebra student.

The gap between secondary education and postsecondary education is particularly noteworthy in Florida. For the school year 2007-2008 in Florida, 37% of the state university students did not pass their college entry-level required math courses needed to satisfy the general education requirements for graduation (ENLACE, 2009). College

algebra is one of several courses that students at the University of South Florida (USF) can take to satisfy a portion of the mathematics general education requirements for a bachelor's degree. This basic course is a prerequisite for students whose SAT scores preclude their enrollment in calculus (see Appendix A). While serving as an instructor of college algebra at USF since 2007, the researcher observed that many students who met the university's entry requirements for college algebra and who enrolled in the course either dropped it or failed it. The average failure rate for college algebra at USF for the semesters from fall 2005 through fall 2008 was approximately 37.6% (see Appendix B). The potential exists for as many as 3,000 USF students to enroll in college algebra every year, which translates to a predicted course failure rate for as many as 1,128 students.

Some of the students who fail college algebra are recent high school graduates whose college preparatory background includes algebra I, algebra II, and/or higher math courses. For other students, a gap of several years may exist since they last successfully completed a math course. The profile of the average high school graduate is worth noting because it may lend insight into why the student may or may not be prepared to perform at the college level in mathematics. Although SAT scores have been consistent over the last 20 years, the learning focus has been on teaching a wider variety of objectives with fewer details, resulting in less readiness and depth of knowledge in math and science (Moffat, 1994; Rothstein, 1993). DeHart (2007) concluded that the scholarly disconnect between K-12 and postsecondary education interferes with the preparation of students for the rigors of college.

Though there are potentially several variables that can lead to failure in college algebra, a prominent issue is student unpreparedness. Often those students who satisfy the placement requirements for college algebra still experience deficiencies in the ability to recall and apply the skills necessary for successful course completion. At the start of a college algebra course, students must be able to quickly apply prior learned skills in order to stay current with the assignments. Even for incoming college students who completed college preparatory math courses remedial placement rates remain high (Hoyt & Sorenson, 2001). For some students, the realization that they are unprepared does not occur to them until they fail an entry-level math course.

Furthermore, passing college algebra is important, because it is a gateway course for several fields of study. Success in entry-level college mathematics and science courses opens the door to careers in the fields of science, technology, engineering, and mathematics (STEM); likewise, failure in these entry-level courses may close the door to those options (Gainen, 1995; Seymour & Hewitt, 1997). The options students pursue when they fail college algebra vary. While some opt for a remediation course, others decide to review the material on their own. A popular choice is to repeat the course until a passing grade is achieved. If none of these options lead to success, then students choose an alternative field of study that does not require college algebra as a prerequisite course.

Of those students who take remedial math courses, only 27% will go on to earn a bachelor's degree, as compared to 58% of students who take no remedial courses and who go on to earn a bachelor's degree (Adelman, 1999). Even though many college algebra students need a semester-long remediation course because they lack prerequisite

skills (Hoyt & Sorenson, 2001), other students may benefit more from an intensive short-term review of previously learned material. Such a review can be conducted at the start of a college algebra course. If a short-term review at the start of a college algebra course can significantly increase the chance of passing without the need for taking an entire remediation course, then the student could complete his or her course of studies in less time with an increased chance of obtaining a college degree.

Some institutions offer summer programs to aid students in reviewing their prerequisite skills for college algebra. Many of these universities, including USF, have no official program for all incoming students. Although USF requires students of low socioeconomic status, first-generation college students, and students who have low placement scores to attend a short summer session prior to the fall semester, not all incoming students are offered the opportunity to complete this program. Thus, another option is necessary. For example, an intensive short-term online review of prerequisite algebra skills completed at the start of a college algebra course might have a positive impact on the rate of student success in this course and eliminate the need for a full semester of remedial course work or the possibility of multiple repeats of the college algebra course due to failure.

Because the structure of algebra is hierarchical, linear, and stable in content, computer technologies and programs can facilitate enhanced reviews for college algebra courses. Studies involving computer-based instructional programs across the disciplines have shown a moderate but statistically significant effect on raising student test scores (Kulik & Kulik, 1991). Online computer review programs are convenient, relatively low

in cost, and can be closely aligned to the classroom instruction. Several commercially available online programs, two of which, Assessment and Learning in Knowledge Spaces ([ALEKS] n.d), and MyMathTest ([MMT] Pearson Education, n.d.b), have been used in recent studies, resulting in positive effects on student success (Burke, 2009; Hopf, 2009; Sperling, 2009).

As the result of a case study at one institution, Burke (2009) reported the results of an intensive 3-week summer study program of prerequisite algebra skills using the ALEKS (n.d.) program. This online program administers assessments and provides individualized learning modules to assist in remediating areas of weakness. One of the requirements for students in this program was to spend 3 hours per day in class working on the ALEKS review. Students who completed the summer study program achieved a 71% increase in college algebra pass rates compared to those students who did not attend the program. However, the overall potential and benefits of similar intensive short-term reviews at the start of a college algebra course rather than during the summer have not been reported in the literature.

A preliminary investigation of the impact of two short-term online review programs—ALEKS (n.d.) and MyMathTest (MMT)—at the start of a course on student success in the course was conducted by the researcher in a college algebra class at USF during the fall 2009 semester. The purpose of that study was to test the data collection and protocols, and use the results to inform a second study. For purposes of this research, that first study is referred to as “Study One” (Hopf, 2009), and the results can be found in Appendix C. The study for this research is referred to as “Study Two.” One of the

findings of Study One indicated students who used either ALEKS or MMT to review the prerequisite college algebra skills performed significantly better on the posttest administered at the end of the review treatment program than the control group students who did not use the review programs. The overall effect sizes for ALEKS and MMT were 0.5, which can be considered as medium, while the overall effect size for the control group was less than 0.1, which can be considered as minute. The three groups did not differ statistically with respect to the departmental final exam administered at the end of the semester.

Though a lack of preparation in the prerequisite skills for college algebra can have an adverse impact on success in the course, there are other variables—such as attitude toward mathematics, instructional practices, and math anxiety—known to have some degree of influence on success in mathematics (Aiken, 1970; Clute, 1984; Hopf, 2009; Sherman & Wither, 2003). In regard to gender differences in college math achievement, female students' grade averages tend to be equal to or slightly higher than male students' grade averages (Bridgeman & Wendler, 1991; Hopf, 2009). In addition, taking higher level math courses in high school, like geometry and algebra, has a positive relationship with college success (Rose & Betts, 2001). Furthermore, high school records that yield information, such as overall GPA, math grade average, and math courses taken in high school are valid predictors of college success (Burton & Ramist, 2001; Hopf, 2009).

Of the factors cited by Burton and Ramist (2001) and Hopf (2009) that are known to influence success in college math, the researcher observed six of those factors in Study One: (a) instructional strategies in the form of two short-term online reviews of the

college algebra prerequisite skills (ALEKS, n.d.; MMT, Pearson Education, n.d.b.), (b) gender, (c) high school math grade average, (d) first attempt at college algebra, (e) time elapsed since the last math course was taken, and (f) highest high school math course taken. In Study One (Hopf, 2009), the results indicated those students who received the online review of college algebra prerequisite skills in either of the two online treatments (ALEKS and MMT) had significantly higher scores on the posttest given at the end of the treatment as compared to those student who did not receive the review treatment. The factors of having an A or B grade average in high school math, attempting college algebra for the first time, or being a female student had a relation to success in college algebra (Hopf, 2009). The remaining two factors, time elapsed since the last math course was taken and the highest high school math course taken, had a negligible impact on success in the course and, for this reason, Study Two did not include these two factors.

Considering a large proportion of students nationally and locally fail college algebra, further study exploring strategies to reduce failure rates in college algebra is needed. It is important to incorporate changes into entry-level college courses such as college algebra with the objective of improving the likelihood of success for underprepared students. The primary goal of this research was to identify factors that may lead to improved student performance in college algebra.

Rationale

The review of the literature indicates that not only is there a high failure rate in college algebra, but also the failure affects students in several ways (see Figure 1). The lack of research regarding the effects of a short-term college algebra readiness skills

review conducted at the start of a semester, especially for one that runs concurrently with the normal teaching sequence, was the primary purpose for conducting the study.

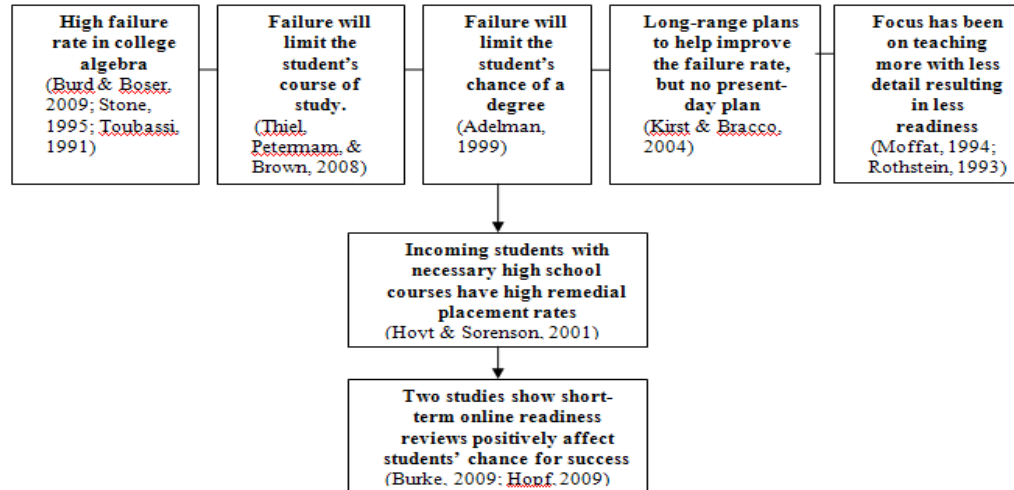


Figure 1. Logic model for rationale.

Purpose

The main focus of this study was to determine whether requiring college algebra students to work a minimum of three hours per week over the first four weeks of the semester with the online program, MMT (Pearson Education, n.d.b.), to supplement the normal sequence of class work and homework would have a significant impact on students' performance in a twofold manner: on a pretest and a posttest of college algebra readiness skills, and on students' performance on the departmental college algebra final exam. This primary part of the study was guided by the following questions.

1. To what extent did college algebra students using the MMT (Pearson Education, n.d.b.) review treatment of prerequisite algebra skills demonstrate

a significantly greater gain from pretest to posttest compared to those students who did not receive the review treatment?

2. To what extent did college algebra students using the MMT (Pearson Education, n.d.b.) review treatment of prerequisite algebra skills show significantly higher achievement on the departmental final exam than those students who did not receive the review treatment?

To gain evidence as to whether the moderator variables—gender and number of attempts taking college algebra—would have a statistically significant effect on the pretest, posttest, and departmental final exam, the following research questions were used to guide the investigation:

3. To what extent was the effect of students' use of MMT (Pearson Education, n.d.b.) on students' performance on the departmental final exam the same for male students and female students?
4. To what extent was the effect of students' use of MMT (Pearson Education, n.d.b.) on students' performance on the departmental final exam the same for students making their first attempt in a college algebra class and students making their second or later attempts in a college algebra class?

The possibility exists that the online MMT (Pearson Education, n.d.b.) review treatment program and/or one or more of the two other external factors may influence students' success in college algebra. As noted earlier, the literature is limited regarding the impact of intensive short-term college algebra prerequisite skill reviews upon student success, thus supporting the premise that this study might contribute to what is currently known. If a specific short-term review program within a college algebra course was found to have a positive impact on students' success in the course, then college algebra instructors could recommend the prerequisite skills review program to their students or require completion of such a review program, thereby increasing students' potential access to the broadest variety of undergraduate majors. Knowing more about the factors

that influence college algebra course success could benefit the institution, the department, and the instructors as they guide students through college algebra courses.

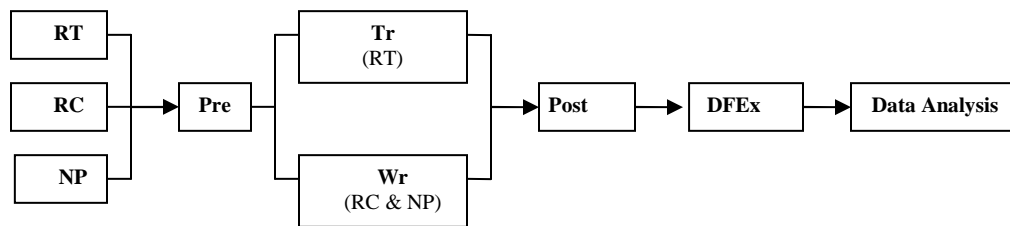
Methods

This research was an experiment involving randomized assignments of students to two groups, treatment condition and control condition, to investigate the differences of the outcomes on a pretest and posttest of college algebra prerequisite skills and on a departmental college algebra final exam. Quantitative methods were used to analyze the data in this study.

To answer the four research questions, this study was conducted in a single, large enrollment ($N > 200$) college algebra class during the fall 2010 semester. Students from the researcher's college algebra class served as the participants in the study. Potential participants were informed of the nature and purpose of the study in order to consent to enter into the study. Details of how the proposed study was to be conducted were provided in the course syllabus (see Appendix D).

The activities associated with the study were done in addition to the normal course requirements. As part of the normal course requirements, all students were to complete weekly graded assignments in an online program called MyLabsPlus ([MLP] Pearson Education, n.d.a.), which served as their homework course grade but was not associated with the data analyzed in the study. All students similarly took an instructor-prepared pretest of college algebra prerequisite skills before the treatment condition began and the same instructor prepared posttest at the end of the treatment, which was marked by the fifth week of classes.

Students who voluntarily consented to participate in the study were randomly assigned to one of two groups: the treatment group who used the MMT (Pearson Education, n.d.b.) online program to review the prerequisite college algebra skills or the control group who had no review of prerequisite college algebra skills, but completed an alternative assignment using MLP and which included practice sets based upon current course content. Students choosing not to participate in the study but who wished to earn the optional bonus grade did the same assignment as the control group, but their data were excluded from the study. A diagram of the procedure for collecting the data for this study is presented in Figure 2.



RT = Randomized treatment group
 RC = Randomized control group
 NP = Nonparticipants
 Pre = Pretest
 Tr = Treatment assignment
 Wr = Writing assignment
 Post = Posttest
 DFEx = Departmental final exam

Figure 2. Procedure flow chart.

As motivation for students to complete the treatment or control condition, each student had the opportunity to earn a bonus grade that was used to replace his or her lowest test score. The progress of the students in each of the two groups was evaluated

weekly according to the grading rubric found in the course syllabus (see Appendix D). Weekly grades for each student were electronically posted during the 4 weeks as well as the overall bonus grade at the end of the 4-week assignment.

The departmental final exam was taken by all students at the end of the semester. Overall, three performance measures (pretest, posttest, and final exam) were taken by all students; data from only those students who consented to participate in the investigation was analyzed. Because the research questions explored performance trends over time, statistical analyses employed a repeated measures analysis of variance. Descriptive statistics, including the data from the self-report survey, were computed and analyzed.

Limitations

Because the study was conducted at a large state university in south Florida, it is somewhat limited in its generalizability. For this same reason, findings resulting from the study may not be representative of those that might be achieved in other settings.

Definitions of Terms

The following terms are used in this study.

College algebra readiness skills (prerequisite skills). These skills are the prerequisite skills students should possess in order to complete one or two entry-level college math courses successfully. In broad terms, these algebraic skills include the ability to solve linear and quadratic equations and inequalities, and to perform operations of addition, subtraction, multiplication, division, and other various algebraic manipulations such as factoring and simplifying polynomial expressions, rational algebraic expressions, and radical expressions. Capacity to solve basic word problems

(e.g., mixture or distance problems), systems of linear equations, absolute value equations, and linear inequalities are included among these algebraic prerequisite skills. Other skills include graphing and identifying important characteristics of linear and quadratic equations.

Departmental final exam. This exam is a common final exam given to all students enrolled in all sections of a particular course. The exam is comprehensive of all the objectives taught in the course; all instructors of the course must use a common standard to assign scores.

Entry-level college math courses. This group of courses includes entry-level fundamental math courses in which freshmen typically enroll upon entering college, such as finite mathematics, liberal arts mathematics, basic statistics, college algebra, trigonometry, precalculus, and calculus.

Gateway math courses. This term refers to entry-level fundamental math courses below the level of calculus. These types of college credit math courses are prerequisite courses that prepare students for higher level college credit courses in mathematics and science.

General education requirement. This term refers to those college credit courses that are part of the group of designated required courses for degree-seeking students.

High school GPA. This term refers to a student's official grade point average for all high school courses that the student has taken using a scale of 0 to 4.0.

High school mathematics grade average. This term refers to a student's mean average grade for all high school mathematics courses taken.

MyMathTest (MMT). MMT is an online review program covering prerequisite math skills for the college algebra course. It has algorithmically generated questions with multiple resources and allows students to respond to open-ended responses (not limited to the multiple-choice format). At the completion of a student assessment, it will create an individualized study plan for the student based on specific areas of weakness (Pearson Education, n.d.b.).

MyLabsPlus (MLP). MLP is an interactive online math program used as a resource to supplement the required textbook in college algebra. It covers skills taught in the college algebra course using algorithmically generated questions with multiple resources. It does allow students to respond to open-ended responses; that is, it is not limited to the multiple choice format (Pearson Education, n.d.a.).

Remedial math course. A remedial math course is a noncredit college math course that covers fundamental algebraic skills, such as those generally required in such courses as basic math, pre-algebra, introductory algebra, or intermediate algebra.

Successful students. Students who receive grades of C- or better in their college math course and/or their departmental final exam are considered to be successful.

Unprepared students. Students who lack algebraic prerequisite skills necessary for success in entry-level college math courses are considered to be unprepared.

Unsuccessful students. Students who voluntarily withdraw from a course or receive grades of D+, D, D-, or F are considered to be unsuccessful.

Summary

A large number of students require remedial instruction to be successful in such entry-level college math courses as college algebra (Hoyt & Sorenson, 2001). College algebra is considered by some to be a gateway course for several majors in college because it is a prerequisite requirement for courses like precalculus and chemistry (Thiel et al., 2008); however, college algebra courses are known to have high failure rates (Burd & Boser, 2009; Stone, 1995; Toubassi, 1991). Unpreparedness on the part of the high school graduate contributes to the high failure rate of students in college algebra courses. Thus, students who place into college algebra by virtue of having completed college prep courses or having achieved satisfactory grades may still need support to be successful in college algebra.

A more immediate solution to the high failure rate in such an important entry-level math course as college algebra is needed. Positive results from a study investigating factors that influence college algebra success would not only contribute to the present literature but might be worthy of implementation in present college algebra classes and worthy of continued study. Institutions, departments, and professors could use this evidence to inform their students about the factors that might improve success in college algebra. Student success in college algebra will likely decrease the institution's overall failure rate and would reduce the frustration levels experienced by students and faculty. Overall, student success can enhance students' learning experience and reduce the costs of education for both the students and the institution.

Organization of the Study

A study of the impact of a short-term review treatment program on student success in a college algebra course is described in the chapters that follow. An overview of the published literature investigating college mathematics success and online math review programs is provided in Chapter 2. Also included in Chapter 2 is an overview of other research variables exploring relevant influence on college math success. Methods and data analysis used in conducting the research for this study are described in Chapter 3. That discussion includes how the findings of Study One (Hopf, 2009) influenced the design of the present study. Results of the analysis of the research questions are discussed in Chapter 4, along with other facts noted that might lead to future investigations of other potential factors known to influence college algebra success. In Chapter 5, a discussion of the findings of this study, including recommendations for future research along with suggestions for possible changes in classroom instruction and institutional policy, are presented.

CHAPTER 2:

REVIEW OF THE LITERATURE

When the national failure rate for a college entry-level course such as college algebra can be as high as 60%, the reasons for such failure are worthy of investigation (Burd & Boser, 2009; Hoyt & Sorenson, 2001; Stone, 1995; Toubassi, 1991). Possible solutions to the problem of a high failure rate in college algebra could involve either long-term or short-term remediation. According to the 2001 National Assessment of Educational Progress (as cited in Braswell et al., 2001), only 17% of high school seniors were considered proficient in mathematics. A lack of mastery of the prerequisite college algebra skills of high school students enrolled in college algebra results in the need for 41% of incoming freshmen having to take one or more remedial or developmental courses (Perin, 2006).

As the review of the literature is examined in the sections that follow, a gap in the literature is revealed regarding remediation of prerequisite skills within a college algebra course, especially using online review programs. This chapter begins with a review of the historical beginnings of the lack of preparedness of college students leading to the need for remediation and an investigation into why high school students are not prepared. In

addition, some of the variables that may influence success in college algebra are described in this chapter.

Overview of College Readiness

According to the U.S. Department of Education (2000), college readiness is one of seven national education priorities. A study by the Iowa City Testing Services (as cited in Cavanagh, 2004) found that 78% of the students who took the ACT math exams in 2004 were not prepared for college-level algebra. Although the Iowa study took place in 2004, Casazza's (1999) research indicated the problem of the need for remediation for entry-level college students has been documented for close to 200 years. Since at least 1996, some efforts have been made to assist states' educational officials in taking action aimed at reducing the number of unprepared students entering college (Achieve, 2011).

In researching the literature regarding weaknesses in the prerequisite college algebra skills of college students, it was found that the problem has a long history, which led to early acknowledgements of the disconnect in the curriculum between what is taught in high schools and what colleges expect incoming students to know. The next sections discuss that history followed by what is being done currently at the national level to make changes in curriculum that will better prepare high school students for college-level courses.

Early Beginning for Remedial Courses

As early as the 1800s, postsecondary schools such as Harvard and Cornell reported difficulties with unprepared students and efforts to address the problem of failure to meet academic standards (Guerra, 2009). Incoming freshmen were noted as

particularly at risk of this shortcoming. In the late 1800s, Charles Elliot, Harvard's president, complained that students were unable to express themselves very well in written form and were unable to use correct spelling and grammar (Weidner, 1990). In an effort to determine the extent of this gap in writing skill, Harvard developed and administered an entrance exam, which 50% of the incoming students failed. This failure spurred Harvard to offer an extra course to prepare the students for courses that were considered college-level (Casazza, 1999). That preparation course was referred to as *remedial writing*, and it marked the beginning of students being accepted into college with the proviso that they take a remedial course.

By the early 1900s, developmental courses such as remedial reading and study skills were being offered by many colleges (Guerra, 2009). In the years since those early remedial college classes were offered, even though high school curricula have improved, institutions of higher education have continued to receive students who are unprepared for college-level courses. According to Merisotis and Phipps (2000), at least 29% of students entering college are required to take remedial mathematics. One possible explanation for the high percentage of entering freshmen requiring remedial instruction could be the misalignment between high school curricula and college curricula (Conley, 2005; Kirst & Bracco, 2004). Another possible reason is a breakdown in communication between high schools and colleges (Conley, 2005; Kirst & Bracco, 2004, Timpane & White, 1998).

Disconnect Between High School and College

To learn more about how high schools' curricula compared to college entrance requirements, the Committee of Ten, composed exclusively of college presidents, was created by the National Education Association of the United States in 1892 to study the curriculum of high schools and the admission requirements for colleges (Casazza & Silverman, 1996). The committee proposed that some of the burden for providing instruction on college curricula be placed on the high schools. According to Casazza (1999), two outcomes of this committee's work were greater standardization among secondary schools and heightened awareness of the need for connectedness between high schools and higher education institutions.

High school students may have completed college prep courses and earned good grades but remain unaware of the emphasis on college placement tests (Kirst, 1998). For example, many colleges and universities require incoming freshmen to take placement tests regardless of high school background. Those students who do not achieve the prerequisite score to enroll in college-level courses are obligated to take one or more developmental or remedial courses prior to placement in college-level courses. Remedial courses often include courses such as arithmetic, geometry, and high school algebra I and II (Adelman, 1999; Sagher & Siadat, 1997). According to Perin (2006), 65% of first-time freshmen in the state of Florida enroll in at least one remedial course.

Misalignment between high schools and colleges has an effect on access to higher education and completion of the college degree (U.S. Department of Education, 2006). According to the U.S. Department of Education (2006), although the number of high

school students who go on to college has risen since 1980, the number of students who complete their degrees has not improved at the same rate. The shortage of college readiness skills means students must take remedial courses to prepare for the coursework necessary to complete a degree. These additional courses are costly to both the student and the institution. According to Conley (2005), the structure of some high school curricula emphasize mastering necessary skills rather than striving to challenge the students to a more rigorous intellectual development. Students who cannot place into entry-level college courses or who must take remedial courses are less likely to obtain a college degree than are their peers who do not encounter this academic hurdle (Merisotis & Phipps, 2000).

National Effort to Bridge the Gap

National programs such as the American Diploma Project (ADP) were put into place to help states make changes in educational policy that will better prepare high school students for college-level courses. The ADP was begun as a collaborative effort by four national organizations and five states and was funded by the Hewlett Foundation to ensure that American high school students would have the skills and knowledge necessary for success after graduation from high school. An ADP research project created mathematics and English benchmarks that relied on input from educators and employers as well as data on employment linked to the courses taken in high school (Carnevale & Desrochers, 2004).

ADP is guided by the efforts of Achieve (2011), a nonprofit reform education organization, to assist the states in aligning curricula between high schools and

postsecondary education. Achieve was created in 1996 by the nation's governors and corporate leaders to help states raise academic standards and bridge the gap for students making the transition between high school and entry into either institutions of higher education or the workplace. At its start, this program was composed of a network of 13 states. As of 2009, the program boasted 35 member states, including Florida. Governors, state education officials, education leaders, and business executives use the network to raise the value of the high school diploma by increasing the quality of assessments and curricula so that the expectations of institutions of higher learning and workplaces can be better met (Achieve, 2011).

While remedial courses may offer the student an opportunity to keep the door open for pursuing a college education, these courses may also have a negative effect (Attewell, Lavin, Domina, & Levey, 2006; Bettinger & Long, 2004). These negative effects may include additional time and expense and still may not lead to ultimate completion of a college degree. The literature points to a trend regarding emphasis at the state level for bridging the gap between K-12 and postsecondary education; however, building this bridge will take time, because new policies must be adopted and implemented before success can be realized (Achieve, 2011). In the meantime, for students facing the prospect of taking college algebra, a course known to have a high failure rate (Burd & Boser, 2009; Stone, 1995; Toubassi, 1991), short-term online review programs maybe a good alternative (Burke, 2009). This evidence suggests a need for more research that will examine to what extent short-term online reviews of prerequisite college algebra skills might have an impact on success in college algebra.

Alternatives to Remedial Courses: Online Review Programs

Intensive Online Reviews to Prepare for College Algebra

According to Kulik and Kulik (1991), computer technologies can facilitate enhanced reviews for college algebra courses, because algebra is hierarchical, linear, and stable in content and structure. A meta-analysis of findings from 254 controlled evaluation studies showed that computer-based instruction usually produces positive effects on students. These studies involved learners of all age levels, from kindergarten pupils to adult students. Computer-based instruction programs raised student examination scores by 0.30 *SDs* in the average study, a moderate but significant effect (Kulik & Kulik, 1991). For purposes of convenience, relative low cost, and closer alignment of instruction with specific student needs, commercial online computer review programs such as ALEKS (n.d.) and MMT (Pearson Education, n.d.b) are becoming increasingly common and accepted (Hopf, 2009; Sperling, 2009).

ALEKS

The ALEKS (n.d.) program for reviewing basic algebra skills—called ALEKS Prep—assesses, instructs, and interacts with the student. Like many online programs, questions are algorithmically generated; a student completing a new assessment will not see a math problem with the same numbers as were seen by another student. This feature minimizes the possibility of cheating. Unlike other programs that pose only multiple-choice questions, ALEKS Prep allows students to input free-response answers. It was designed with artificial intelligence, and the assessment is conducted with adaptive testing. The advantages of this program are that students review only those topics in

which they are deficient, can progress at their own pace, and can proceed without teacher-led instruction. These benefits make ALEKS a resource to which instructors and institutions could refer unprepared students as a requirement that students could complete outside of class on their own time, thereby obviating or at least reducing reliance on teacher-directed remedial learning.

A case involving the exclusive use of ALEKS for successful placement and remediation of students was reported by the University of Illinois (n.d.):

The University of Illinois requires the U of I Math Placement Exam through ALEKS to assess a student's prerequisite knowledge for course placement. ALEKS is a powerful artificial-intelligence based assessment tool that zeros in on the strengths and weaknesses of a student's mathematical knowledge, reports its findings to the student, and then if necessary provides the student with a learning environment for bringing this knowledge up to an appropriate level for course placement. (University of Illinois, n.d., para. 1)

Since the University of Illinois began using the ALEKS program, it has experienced an increase in pass rates in its math courses, and those students who passed their first mathematics class were more likely to enroll in a second (Burke, 2009).

Another possible application for ALEKS Prep is for students to use it as an intensive review a few weeks prior to taking a college algebra class. In an effort to ensure that students with low placement scores were prepared for their college math, ALEKS Prep was used by students at Southern Connecticut State University under the direction of Dr. Emmett Dennis. His findings indicated that students who participated in an intensive 3-week review of basic algebra skills using ALEKS during the summer prior to the fall semester in which they would enroll in a math course experienced better pass

rates in those fall math courses than did those students who did not undergo the intensive review using ALEKS (Burke, 2009).

MyMathTest

MMT (Pearson Education, n.d.b) was not designed with artificial intelligence and does not use adaptive testing. However, it allows students to input free-response answers. The questions posed by MMT are algorithmically generated so that students can rework and retest without seeing the same numbers in any given question. Elements of this program “can also be used to deliver short-term, refresher courses that allow students to review and prepare before taking a placement test” (Pearson Education, n.d.b, para. 1).

The advantages of MMT (Pearson Education, n.d.b) are similar to those of ALEKS Prep. Students review only those topics in which they are deficient, they can progress at their own pace, and they can proceed without teacher-led instruction. Like ALEKS Prep, the functionality and features of MMT make it a source to which instructors or institutions could refer unprepared students as a requirement that students could complete outside of class, on their own time, with little to no reliance on teacher-directed learning.

Some universities, such as the University of Maine–Augusta, refer students to MMT as a review of basic algebra skills as they prepare for the institution’s math placement test. According to the University of Maine–Augusta, “The study plan shows you what concepts you need to work on based on your test results and helps you learn the concepts through tutorials and videos” (University of Maine–Augusta, n.d., para. 2).

ALEKS (n.d.) and MMT (Pearson Education, n.d.b) are among the top online math review programs chosen by institutions of higher learning, as evidenced by a study commissioned by the Massachusetts Community Colleges Executive Office to examine community colleges' developmental education best policy and practices:

Several colleges reported explorations into basic skills assessments that are more diagnostic than the *Accuplacer* exam, now used by all of the colleges for mandatory—or, in two cases, advisory—course placement purposes. A few of the institutions are piloting *ALEKS* and *Advancer*, both instruments that have been developed with cross-walks to *Accuplacer*. In addition, at least one institution is piloting *MyMathTest*, to interface with individualized instruction using *MyMathLab*. Colleges that are considering these exams are interested in identifying and providing more focused instruction on specific skill gaps as well as strengths that students display in order to better individualize developmental curricula and instruction. (Sperling, 2009, p. 70)

Evidence such as this can lead to informed choices in selecting online review programs for students needing some level of review for prerequisite algebra skills.

It is important for the objectives of an online review program to be aligned with an institution's prerequisite algebra skills for college algebra. Both ALEKS and MMT have databases of questions that are structured in such a way to make it possible to customize the specific readiness algebra skills an instructor or institution would want to include in an assessment and/or review.

Prerequisite Algebra Skills for College Algebra

Students taking college algebra should have recall of certain algebraic skills that are prerequisites for success in the course. These skills include topics such as simplifying algebraic expressions, performing operations with polynomials, factoring polynomials, solving linear equations and inequalities, solving quadratic equations, and graphing in an x - y coordinate system. Because the topics taught in college algebra may vary slightly

among institutions, colleges and universities may expect their students to possess different specific prerequisite algebra skills.

This section includes a list of some of the math concepts important for college readiness at the national level based on national placement tests and is followed by a more specific discussion regarding what the Florida Department of Education is doing, as of 2011, to address the alignment of mathematics standards for K-12 and postsecondary education.

National Guidelines

Organizations such as the College Board, which administers mathematics tests used by many colleges and universities for placement purposes, pose questions that typify the concepts generally deemed necessary for college algebra. The College Board Scholastic Aptitude Test (SAT), which many high school students take, includes questions from the following three areas: (a) algebra and functions; (b) geometry and measurement; and (c) data analysis, statistics, and probability (College Board, n.d.). Because of the broad topic areas on the SAT, subject-area tests are administered using products such as ACCUPLACER, an online adaptive test from College Board.

Florida Guidelines

The Florida Department of Education (n.d.) has set math standards or benchmarks for K-12 mathematics education. Surveys were administered to approximately 25 of Florida's secondary and postsecondary math educators, who were asked to rank a list of skills they believed were essential for college math readiness. The list included in the survey had been prepared by Achieve (2004) as part of that organization's ADP. The

resulting rankings were subsequently aligned to the Florida K-12 Next Generation Sunshine State Standards. The knowledge gained from the survey was the catalyst to help structure reforms for secondary education, the objective of which was to better prepare high school students for college entry-level math courses.

Variables That May Influence College Algebra Success

Various studies have shown that several external factors may have some effect on student success in college math courses and include such factors as attitude toward mathematics, math anxiety, instructional strategies, and several demographic variables. A review of the studies involving these variables and to what extent that may influence success in college math follows.

Attitude Toward Mathematics

Ma and Kishor (1997), in a meta-analysis study, found a small consensus in the research literature as to how attitude towards mathematics relates to achievement in mathematics. A result of a more recent study that investigated student attitudes, perceptions, and achievement in an undergraduate statistics course indicated a low correlation between positive attitudes toward math and accurate conceptions about math (Evans, 2007).

Math Anxiety

Anxiety is a factor mentioned in the literature as affecting achievement but, again, the consensus was not strong and varied according to the study. In an earlier study relating anxiety to achievement when comparing two teaching approaches—expository and discovery—one of the outcomes showed that students with high anxiety had

significantly lower achievement than did students with low anxiety (Clute, 1984).

However, a different study regarding whether math anxiety caused a deterioration of math achievement rejected the premise that math anxiety causes the deterioration of math achievement (Sherman & Wither, 2003).

Instructional Strategies

Another external factor known to have an impact on learning is instructional strategies that incorporate teaching methods, which engage the student in active learning and move beyond just listening to a formal lecture in the classroom.

[S]tudents must do more than just listen: They must read, write, discuss, or be engaged in solving problems. Most important, to be actively involved, students must engage in such higher-order thinking tasks as analysis, synthesis, and evaluation. Within this context, it is proposed that strategies promoting active learning be defined as instructional activities involving students in doing things and thinking about what they are doing. (Bonwell & Eison, 1991, p. 1)

Instructional strategies that involve students in doing things and thinking about what they are doing can be implemented in a variety of ways, as shown in the conclusion to the meta-analysis study indicating small-group learning as being effective for promoting achievement (Springer, Stanne, & Donovan, 1999). More recent studies regarding the use of blended formats as the teaching method, which resulted in a positive impact on success in a college algebra classroom, was the use of online web-based homework or reviews in addition to the traditional lecture class (Hopf, 2009; Li, Uvah, Amin, & Okafor, 2010).

Another instructional strategy known to promote student learning is the practice of students writing solutions to mathematics problems, thereby enhancing their mathematical reasoning (Pugalee, 2001). Angelo and Cross (1993) described suggestions for using writing as an instructional strategy for student learning.

High School Math Grade Average

High school math grade average and college GPA are known to influence college success (Johnson, 1996; Little, 2002). In a study on predictive relationships between high school mathematics and success in college algebra, Hunt (1987) found that, of those factors that significantly correlated with success in college algebra, the high school academic mathematics grade average resulted in the highest single r value. In addition, high school records that yield information such as math grade averages are valid predictors of college success (Burton & Ramist, 2001).

First Attempt at College Algebra

A student taking college algebra for the first time may or may not have the same advantage as the student who is taking the course for the second or third time. Little information is available in the literature on the success of first-attempt college algebra students. Hopf (2009) noted that first-attempt students in college algebra had 25% higher success rates in passing the course than multiple-attempt students. Most studies (Horton, 1998; Hunt, 1987; Little, 2002) that correlated factors influencing success in college algebra did not differentiate between those students who made first attempts and those who made multiple attempts, nor did they offer insight into whether the first-attempt students had a higher or lower failure rate than did the multiple-attempt students.

Gender

Literature from the 1970s and 1980s on the topic of gender and mathematics achievement revealed that gender differences do not surface until the secondary school years and usually favor boys over girls (Armstrong, 1981; Fennema & Sherman, 1978).

Later studies yielded contradictory results, suggesting that either girls performed higher than boys (Galbraith, 1986) or that there was no significant difference in their performance (Swafford, 1980). However, the general consensus is that girls tend to perform better than boys in computation, and boys tend to perform better than girls in problem solving (Hyde, Fennema, & Lamon, 1990). A study of the relationship between beliefs and remedial college-level student achievement indicated no significant difference in terms of gender but did show a stronger relationship between beliefs and course grades for women than for men (Stage & Kloosterman, 1995). In general, those earlier studies were shown to be inconsistent in terms of findings regarding how gender influences success in mathematics.

Results from some more recent studies support gender as one of several predictors or factors that influenced success in remedial and/or college-level courses. A study by Little (2002) focused on the factors influencing the success of students in introductory algebra and found seven variables that significantly aided success in introductory algebra; gender was the fourth of seven variables identified when listed in order of influence. Female students' grade averages tend to be equal to or slightly higher than male students' grade averages when comparing gender to college math achievement (Bridgeman & Wendler, 1991; Hopf, 2009). When academic and demographic variables were used to predict success in a college curriculum, gender was among four noted as predictors of success (Horton, 1998). The gap in success attributable to gender difference has become less significant but remains among the variables known to aid in predicting success in college math courses.

Summary

A lack of readiness exists for high school students entering college (Cavanagh, 2004). The disconnect between secondary and postsecondary education (Conley, 2005; Kirst & Bracco, 2004) accounts for some underprepared college students, and efforts have been made to bridge that gap (Achieve, 2011). However, support is needed for students entering college before that bridge has been completed. As many as 25% or more of entering college freshmen will need to take remedial math courses but such courses are not always the answer (Merisotis & Phipps, 2000). An alternative support for the underprepared student entering college algebra might be a short-term review with an interactive online program (Burke, 2009).

CHAPTER 3:

METHODS

This research was a quantitative study that investigated the effectiveness of a short-term online review treatment program given at the beginning of a college algebra course on students' achievement as measured by the scores on a pretest and posttest of prerequisite college algebra skills as well as on students' later success on the college algebra departmental final exam. There were external factors involved in this study such as the teacher, classroom environment, and curriculum; these factors were constants because the sample was part of a single specific college algebra class led by the researcher. The researcher could not control for the demographics and prior experiences of students at the start of the study.

Two main research questions were addressed in this study: To what extent did college algebra students using the MMT (Pearson Education, n.d.b) review treatment of prerequisite algebra skills demonstrate a significantly greater gain from pretest to posttest compared to those students who did not receive the review treatment, and to what extent did college algebra students using the MMT review treatment of prerequisite algebra skills show significantly higher achievement on the departmental final exam than those students who did not receive the review treatment?

Secondarily, this study investigated two moderator variables, gender and first attempt at college algebra. In exploring these factors, the research was guided by the following two research questions: To what extent was the effect of students' use of MMT (Pearson Education, n.d.b) on students' performance on the departmental final exam the same for male students and female students, and to what extent was the effect of students' use of MMT on students' performance on the departmental final exam the same for students making their first attempt in a college algebra class and students making their second or later attempts in a college algebra class?

Participants

Students who met the placement criteria for college algebra at USF in fall semester 2010 were able to enroll in any one of the five large lecture class sections of approximately 240 students taught by six different instructors. The study was conducted in the section taught by the researcher and represented approximately 16% of the USF college algebra population in the fall semester.

USF College Algebra Student Profile

Most of the incoming USF students in the fall semester who register for college algebra are in their first year of college. If students have a minimum score of 490 on the SAT math or a score of 21 on the ACT math, then they are eligible to enroll in college algebra (see Appendix A). In a recent USF fall semester class of college algebra, close to 90% of the students were taking the course for the first time. Approximately 87% of the students had a high school math grade average equal to a grade of B or higher, and slightly more than half of the students were female (Hopf, 2009).

Recruitment

The registration for the researcher's section was closed on the first day of the first week of the start of the semester unlike the other class sections, which remained open for the first week. That is, students were not allowed to enroll in and enter the course after that date. Of the 240 students registered for the researcher's college algebra class, 227 students attended the first day and were considered the potential research participants. A "first-day" attendance policy has been employed at USF since 1996 (USF, n.d.a).

According to that policy, any student who is listed on the official class roster and who does not attend the first day of class will be dropped from the course. Also, students are allowed to drop and add courses during the first week of the semester without penalty. As a result, the researcher's first class-day roster of 227 ended up at 219 after the first week of the semester. Of the 219 students on the roster, 187 signed a consent form to participate in the study. This number represented approximately 85% of the students in the class. When the researcher conducted Study One (Hopf, 2009), approximately 95% of the 231 students present on the first day of class consented to participate in the study.

As an incentive for students to consent to participate in this study, the researcher awarded a course bonus grade for the two group assignments related to the research study. A grading rubric was designed as a means to assign points for the work and time completed. This provided an opportunity for both the students receiving the MMT online review treatment (treatment group) and those students not receiving the MMT online treatment (control group or nonparticipants) to earn points to replace their lowest test score.

Informed Consent

The research study was explained on the first day of class and an informed consent form (see Appendix E) was distributed to students. Students were requested to review the informed consent form and ask any questions they might have about the study (e.g., its purpose, its process, or how the information might be used). The researcher made it clear that participation in the study would not give the student an unfair advantage over those who choose not to participate. Those students who agreed to participate in the study were instructed to sign and submit to the researcher the informed consent form provided for this purpose. A copy of the signed informed consent form was returned to the student. Using the original signed form, an identification code was assigned to each participant's name on each form. The consent forms, along with other data collected for this study, are stored in a locked cabinet in the researcher's office at the University of South Florida. The consent forms and other data collected will be stored in the researcher's office for 5 years, after which they will be shredded.

Random Group Assignments

The students who consented to participate in the study were randomly assigned to one of two groups—the review treatment group, who used the MMT (Pearson Education, n.d.b) online program to review prerequisite college algebra skills, or the control group, who did not receive the MMT online review but instead completed an alternative assignment using the online program, MLP (Pearson Education, n.d.a) that was based upon college algebra course content. The procedure for randomizing the assignment of students to a specific group was done by rank ordering of the pretest scores given on the

first day of class, pairing the scores in the rank order, and then, from within each pair, one student was randomly assigned to a group by tossing a coin.

Description of the Groups

Students in the treatment group used the MMT (Pearson Education, n.d.b) program to review the prerequisite college algebra skills in an online interactive learning environment. MMT creates a personalized study plan consisting of problems to be solved, incorporating multiple forms of support to assist in the student's acquisition of the specific skill. The multiple forms of support include (a) instruction by guided questions, (b) illustrative examples of a step-by-step solution to a similar problem, (c) a video of an instructor solving a similar problem, and (d) an animated slide presentation demonstrating how to do a similar problem. Thus, when a student selected an exercise set from one of the topic areas in his or her study plan, a series of problems were displayed, one at a time, with access to the multiple resources linked to each question. The student could make an unlimited number of attempts of the same problem and receive immediate feedback each time. This process was continued throughout the 4-week treatment period, culminating with a final MMT assessment. These elements parallel the structure of the MLP (Pearson Education, n.d.a) online resources that are part of the normal college algebra course requirement for all students.

Students in the control group spent three hours per week during the first four weeks practicing extra homework exercise sets using MLP (Pearson Education, n.d.a). Assignments for the control group did not include any prerequisite college algebra skill problems but was a supplementary set of exercises complementing the regular weekly

lesson. The college algebra students who chose not to participate in the study had the opportunity to earn bonus points by completing the same condition as the control group.

Instruments

Student Self-Report

This study examined two moderator variables—gender and first attempt at college algebra. The data for these two variables were collected on the first day of class by means of a self-report survey (see Appendix F). Students who had missing data were asked to complete the missing information on a subsequent class day.

Pretest and Posttest

To assist in measuring whether the students who received the MMT (Pearson Education, n.d.b) review treatment performed differently from the control group, a pretest and a posttest were administered by the researcher. It was a criterion-referenced test consisting of 35 questions selected using the MLP (Pearson Education, n.d.a) database of prerequisite algebra skill questions (see Appendix G). The questions were a representation of the 20 algebra skills identified as most necessary for passing college algebra (see Appendix H) in a study conducted by the Florida Department of Education. To provide a more consistent measure, the same test was given for both the pretest and posttest. To verify that the pretest and posttest had an acceptable reliability, the suggestion of Cortina (1993), that a Cronbach's alpha of .70 or higher is acceptable, was followed. In the 2010 spring semester, the researcher gave 123 college algebra students an earlier version of the pretest and posttest. When the test reliability was analyzed, it was found to have a Cronbach's alpha of .77 (see Appendix I). For this research study the

pretest and posttest reliability had a Cronbach's alpha of .67 and .73, respectively, when analyzed.

Departmental Final Exam

The departmental final exam is a comprehensive exam taken by all students in the department enrolled in college algebra in a given semester. This exam was used as a measure of student success in the course for both the MMT review treatment group and the control group. It was composed of 40 five-option multiple-choice questions developed by the department program director (not the researcher) specifically for college algebra classes at USF. According to a report from the program director, the test has been found to have an acceptable reliability measure with a Cronbach's alpha of .81 (see Appendix J). For this research study the final exam test reliability had a Cronbach's alpha of .83 when analyzed. Questions on each year's exam are unknown to the instructors until the exam is actually administered to the students. Each year's final exam must be administered by all college algebra instructors.

Data Collection

Specific details on who the participants for this study were, the instruments that were used, and the general procedure for collecting the data are presented in Figure 3.

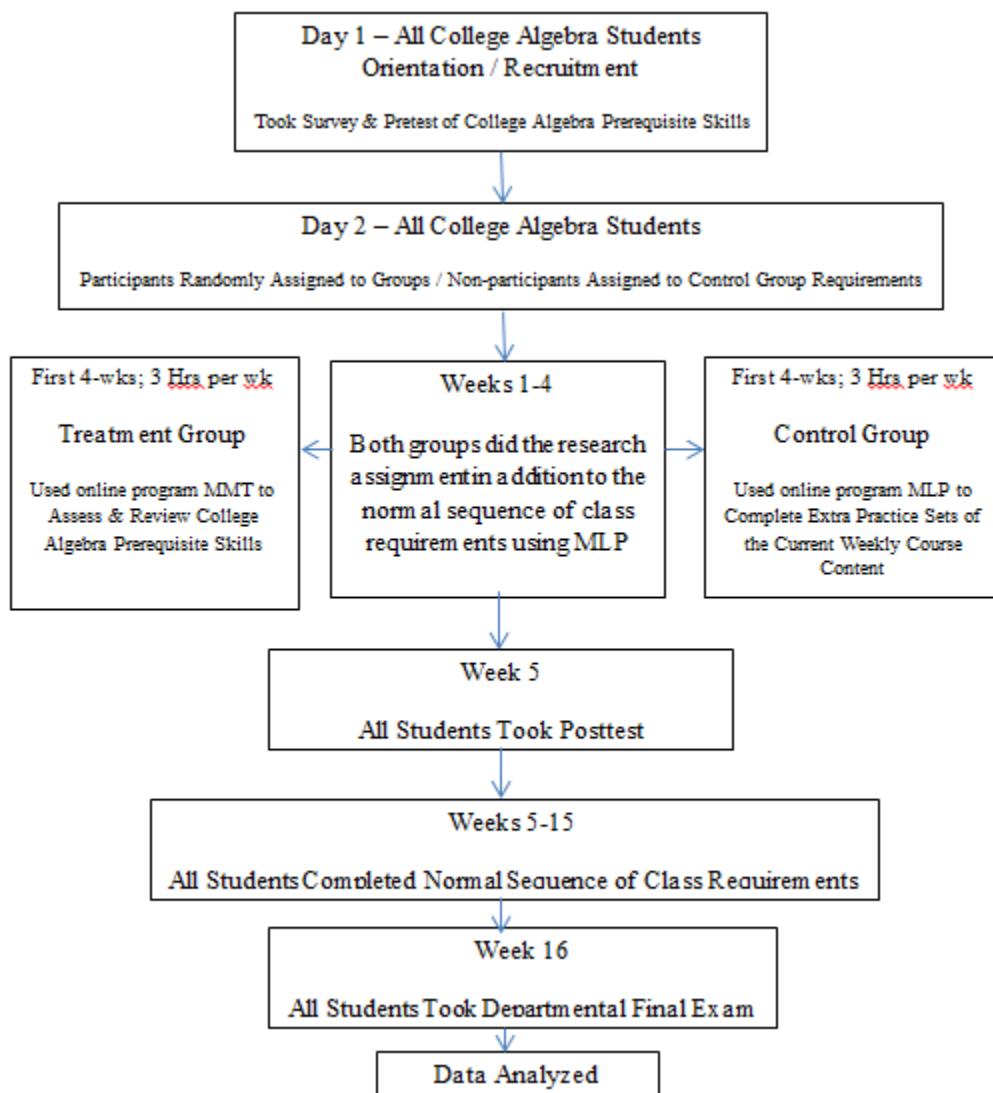


Figure 3. Overview of the data collection procedures. The research assignments were completed using the interactive online programs MyMathTest, MMT (Pearson Education, n.d.b.), and MyLabsPlus, MLP (Pearson Education, n.d.a.).

The design of the researcher's college algebra class, as stated on the course syllabus, had three major components—lecture sessions, interactive learning sessions,

and online graded homework using MLP (see Course Syllabus in Appendix D). Each of these three components includes specific teaching strategies.

Lecture class: The lecture instructor did the following:

1. Presented the course material and posted class notes on Blackboard;
2. Practiced problems with students;
3. Administered class participation problems to which students responded by using their clickers.

Interactive learning session: The lecture instructor assisted by the graduate teaching assistants did the following:

1. Answered homework questions from the textbook and the online homework;
2. Facilitated completion of worksheets in groups or individually;
3. Administered quizzes to which students responded by using their clickers.

Online graded homework: All students were required to complete and submit weekly homework assignments via an online program, MLP (Pearson Education, n.d.a).

As clearly stated in the course syllabus, all students in the researcher's college algebra class (irrespective of a student's voluntary participation or nonparticipation in this study) had the following course requirements:

1. Attend all lecture classes, Friday interactive sessions, and exams.
2. Spend at least 9 hours per week reading, practicing, studying, and discussing this course.
3. Take a pretest of college algebra prerequisite skills on the first class day of the semester.
4. Take a posttest of college algebra prerequisite skills at the end of the first 4 weeks of the semester.

5. Have the opportunity to complete an optional bonus grade assignment (which can replace the lowest chapter test grade if it is higher) over the first 4 weeks of the semester.
6. Take three chapter tests.
7. Take a 2-hour departmental final exam that will be cumulative.
8. Complete online graded homework in MLP (Pearson Education, n.d.a).
9. Participate in the lecture class by responding with a clicker (remote wireless responder) to questions posed by the instructor.
10. Take quizzes in Friday interactive sessions.
11. Complete a weekly, 15-question, online worksheet at MLP (Pearson Education, n.d.a).

The bonus grade assignment, intended to be an incentive for students who wanted to participate in the study and complete it with an earnest amount of work, consisted of two assignments (the online review of prerequisite college algebra skills using MMT (Pearson Education, n.d.b) or the four extra sets of exercises covering the current weekly course content using MLP (Pearson Education, n.d.a). Students must have completed one of the two assignments to be eligible for the bonus grade. Because the study was conducted exclusively in Florida, the researcher adjusted the objectives of the online treatment program, MMT, so that the questions in the review focused on algebra readiness skills that closely aligned to the top 10 benchmarks identified by the survey conducted by the Florida Department of Education (n.d.)

The description of the two assignments as they appeared in the course syllabus follows.

1. The treatment group using MMT. Students will complete the weekly hours and assessments in an online review of the prerequisite college

algebra skills using MMT (see grading rubric at end of syllabus.). In addition to the normal sequence of course homework using MLP, students in the treatment group will be required to spend 3 hours per week for the first 4 weeks of the semester reviewing the prerequisite algebra skills.

An access code will be provided to the students assigned to the MMT review treatment group, which will allow access to the web-based MMT online program from their own personal computer or from a computer in a lab on campus. Upon accessing the program, students will be required to complete an initial MMT assessment that allows the program to identify each student's skill strengths and weaknesses. Once this has been determined, a study plan presents the students with learning modules in the areas of weakness to study and practice. This should help facilitate the student's mastery or improved proficiency in those objectives not passed on the initial MMT assessment.

At the end of the 4 weeks the students will take a final assessment in the MMT program. A grade will be assigned to the students in the MMT review treatment group according to completion of the 3 hour per week time requirement at 19 points possible each week for a total of 76 points and their scores on the initial and the final MMT assessment worth 24% of the grade for a total of 100%.

Mastery level, which ensures students have a command of the prerequisite skills necessary for college algebra, will be set at 100%. Students, who achieve mastery level on all areas indicated in the initial assessment before the end of the first 4 weeks may take the final MMT assessment early. Should the student score 100% on the final assignment before the end of the 4 weeks of the treatment, then they will receive a bonus grade of 100% and will not be required to continue in the MMT program. At the end of the 4-week period allotted for the skills review, those students still working in the program will take the final MMT assessment. All students in the MMT treatment group will have their access to the MMT program terminated at the end of the 4 weeks.

2. The control group using MLP. Students will complete the extra exercises covering the weekly course content using MLP (see grading rubric at end of syllabus.). In addition to the normal sequence of course work using MLP, each week students in this group will be granted access to an extra exercise set of questions covering the content studied that week. Access will begin on Monday and will end

at midnight on Sunday. Students will be allowed three attempts at each problem. Any problems not completed by the Sunday deadline will be marked incorrect. There will be no make-ups and no extended deadlines. If all the questions are completed by the deadline, then students will be given 19 points each week for their submission for a total of 76 points. The program will check your work for accuracy and give you a grade each of the 4 weeks. The four accuracy grades will be averaged and 24% of that average will be added to the sum of your weekly submission points for a final total of 100 %.

In the 11 weeks following the 4-week treatment period, course instruction was the same for all students. The departmental final exam was administered by the researcher during the 16th week of the semester in a paper-and-pencil format, and the students used a Scantron form to record their final answers. These Scantron forms were given to the program director for scoring, and once scoring was completed, the raw scores were sent to the instructors in an electronic format.

Data Analysis

One commonly used approach for data analysis in exploratory studies when the literature base is not very strong is to establish the overall statistical significance level for testing hypotheses (Stevens, 1999). For this study, a significance level of $\alpha = .05$ was used. Presented in Table 1 is a summary of the four research questions, the variables for each question, and how the data were tested for that specific question.

Data from only those students who consented to participate in the study, fulfilled the requirements of the study, and took the departmental final exam were analyzed. The bonus grade awarded each student in the class according to which of the two assignments he or she completed was not used in the analysis for the study. The pretest-posttest scores were used for purposes of analysis in the study but were not part of students' final course

grades. In all, 22 students who consented to being in the study had incomplete data scores due to various reasons and were not used in the final analyses.

Table 1

How Each Research Question was Tested

Research question	Variable	Analysis
1. To what extent did college algebra students using MMT review treatment demonstrate a significantly greater gain from pretest to posttest compared to those students who did not use the review treatment?	Levels of independent: Review treatment group and control group Time (Pretest, Posttest) Dependent: Test scores	2 x 2 repeated measures ANOVA
2. To what extent did college algebra students using MMT review treatment show significantly higher achievement on the departmental final exam than those students who did not use the review treatment?	Levels of independent: Review treatment group and control group Dependent: Departmental exam score	One-way ANOVA
3. To what extent was the effect of students' use of MMT on students' performance on the departmental final exam the same for male students and female students?	Independent: Group (Review treatment group and control group), Gender Dependent: Departmental exam score	2 x 2 factorial ANOVA
4. To what extent was the effect of students' use of MMT on students' performance on the departmental final exam the same for students making their 1st attempt at college algebra and students making multiple attempts?	Independent: Group (Review treatment group and control group), Attempts (1 st and multiple student groups) Dependent: Departmental exam score	2 x 2 factorial ANOVA

Descriptive statistics for all data were computed and analyzed, including the student demographics: gender and first attempt at college algebra. For purposes of confidentiality, data collected and analyzed in this study were kept confidential by using the participant's identification code and stored in electronic form. The data were collected and monitored periodically throughout the semester by the researcher.

Summary

A quantitative study involving 187 students enrolled in a college algebra course at USF was performed as a means of evaluating the effectiveness of the MMT (Pearson Education, n.d.b) online review program by comparing students' academic success in the MMT treatment group with the academic success of students in the control group who had an alternative assignment. Participants in the treatment group reviewed prerequisite college algebra skills using the online program MMT, while participants assigned to the control group were asked to complete four extra exercise sets using MLP (Pearson Education, n.d.a).

Data were collected with the following instruments: (a) a self-report survey; (b) pretests and posttests in a pencil-and-paper test format; and (c) a departmental final exam. Data were analyzed for those students who participated in the study, completed the review treatment requirements, and took the departmental final exam. The analyses for the four research questions were computed using either a one-way ANOVA, a repeated measures ANOVA, or a 2 x 2 factorial ANOVA test.

CHAPTER 4:

RESULTS

The purpose of the study was to investigate the effects of a short-term review of college algebra prerequisite skills presented at the beginning of a college algebra course supplementing the traditionally taught course content; in particular, whether the online review of prerequisite skills would have a significant impact on the posttest or on the departmental course final exam. Participants in the study were randomly assigned to one of two groups. The treatment group used the online program, MMT (Pearson Education, n.d.b), to review prerequisite algebra skills while the control group completed additional college algebra exercises concurrent with their course assignments. Presented in this chapter are an overview of the participants in the study and a discussion of the reliability of the scores from the instruments. It also provides a description of the data collected as well as the data analyses for each research question.

Overview of Participants

There were 240 students listed on the original class roster for the first day of class. While USF has a first week drop/add policy, allowing students to drop and/or add classes with no penalty, the researcher's class was closed to new students from the first day of the semester. Therefore, once this first week elapsed, 219 students remained on the roster.

Of those 219 students, 187 voluntarily signed consent forms to participate in the research study, representing approximately 85% of the class roster.

Of these 187 students originally consenting to be in the study, 165 students subsequently completed all of the necessary tests for analyses. In all, 22 students originally consenting to participate in the study had incomplete data scores due to various reasons and were not used in the final analyses. Of the 22 students, 14 were dropped from the study because they had missing data for one or more of the dependent variable scores and two were dropped because they did the wrong assignment for their assigned group. Five students withdrew from the course without grade consideration and one student received an incomplete grade for an approved medical reason that prohibited her from taking the departmental final exam. Presented in Table 2 is a comparison of the original number of participants in the study and the number of participants who completed the study.

Table 2

Comparison of Original Number of Participants and Final Number of Participants

Group	Original ($n = 187$)	Missing data ($n = 16$)	Withdrawals/incompletes ($n = 6$)	Final ($n = 165$)
Treatment	49.7%	43.8%	66.7%	49.6%
Control	50.3%	56.2%	33.3%	50.4%

The mean of the pretest scores of the participants completing the study ($M = 43.6$) was similar to the mean of the pretest scores of the non-participants in the study ($M = 42.5$).

However, students remaining in the study until the end had a mean pretest score of 44% while the 16 students with missing data had a mean pretest score of 38% and the six students withdrawing or with incomplete grades had a mean pretest score of 30%.

Two of the research questions involved gender of the participants and whether or not this was their first attempt at college algebra. Provided in Table 3 is a description of the number of participants by gender and attempts at college algebra.

Table 3

Number of Participants by Gender and Attempts at College Algebra

Group	Original number of participants (n = 187)		Final number of participants (n = 165)		Final number of 1st attempt (n = 147)		Final number of multiple attempts (n = 18)	
	Males	Females	Males	Females	Males	Females	Males	Females
Total	62	125	52	113	45	102	7	11
Treatment	30	63	25	57	21	53	4	4
Control	32	62	27	56	24	49	3	7

When analyzed using a Pearson chi-square test, the percentage of participants that were making their first attempt at college algebra or more than one attempt at college algebra did not differ by gender, $\chi^2(1, n = 165) = 0.51, p = .48$. In general, the ratio of female students to male students was 2 to 1. This is similar to the 1.5 to 1 female-to-male student ratio for the incoming freshmen to the university in the fall 2010. Of the students remaining in the study, 89% were making their first attempt at college algebra.

Reliability of Scores from the Instruments

The study used the one 35-item test of prerequisite skills as both the pretest and the posttest. It was generated from the MML (Pearson Education, n.d.b) test software

after the researcher selected items best representing the 20 objectives most necessary for entrance into college algebra. The items were aligned with objectives ranked as most necessary prerequisite skills for college algebra from a survey of Florida secondary and postsecondary mathematics instructors (see Appendix G and Appendix H). The pretests had a Kuder Richardson (KR20) reliability coefficient of .71 and the posttest had a KR20 coefficient of .75, indicating a fair level of internal consistency reliability (Cortina, 1993).

As a means of measuring student achievement at the end of the semester, the researcher used the data from the course final exam that all college algebra students in the department are required to take. This was a 40-question comprehensive final exam developed annually by the program director, not the researcher, specifically for USF college algebra students. When assessed for internal reliability, a KR20 coefficient of .83 was obtained which indicates acceptable reliability.

Data Collection/Descriptive Statistics

All students were given a pretest of college algebra prerequisite skills on the first day of class. Students consenting to participate in the study were then randomly assigned to a treatment group or a control group using the following scheme. The pretest scores were ranked from highest to lowest score. Group assignment was done in pairs taken from a ranked list of the pretest scores given on the first day of class. From within each pair, one student was randomly assigned to a group by tossing a coin. The original group assignment was 93 participants in the treatment group and 94 participants in the control group. The pretest was administered to all study participants on the first day of class and the same test was given as the posttest at the end of the 4-week treatment period. All of

the students in the study took the departmental final exam at the end of the 16-week semester. A presentation of the descriptive statistics for all study participants' ($n=165$) pretest, posttest, and departmental exam scores appears in Table 4, and in Table 5 are presented the descriptive data for the treatment and control groups for pretest, posttest, and final exam scores. As indicated in these tables, the mean scores for the two groups for the pretest, posttest, and final exam scores were similar to the overall mean scores of the three tests.

Table 4

Descriptive Statistics for the Overall Pretest, Posttest, and Exam Scores (%)

Test	<i>N</i>	<i>M</i>	<i>SD</i>	<i>Mdn</i>	Min	Max	Skew	Kurtosis	KR20
Pre-	165	43.6	13.3	43	11	74	0.18	-0.27	.71
Post-	165	56.6	13.4	57	17	83	-0.46	-0.13	.75
Exam	165	59.3	15.6	58	20	95	0.08	-0.42	.83

Note: The researcher has observed in past semesters that exam scores tend to be lower than the overall achievement of the student.

Table 5

Descriptive Statistics for Treatment and Control Groups (%)

Test	<i>N</i>	<i>M</i>	<i>SD</i>	<i>Mdn</i>	Min	Max	Skew	Kurtosis
Treatment group								
Pre-	82	43.2	13.7	43	11	74	0.10	-0.30
Post-	82	57.3	13.0	60	17	80	-0.65	0.37
Exam	82	59.2	14.4	58	25	90	0.13	-0.17
Control group								
Pre-	83	44.0	13.0	43	11	74	0.29	-0.25
Post-	83	56.0	13.8	57	17	83	-0.30	-0.43
Exam	83	59.5	17.0	58	20	95	0.05	-0.65

Note: In general, the average scores for the treatment group and control group tended to be low.

When comparing the pretest scores of the treatment group ($M = 43.2$, $SD = 13.7$) with their posttest scores ($M = 57.3$, $SD = 13.0$), a statistically significant correlation ($r = .54$, $p = 0.001$) was found. When comparing the pretest scores of the control group ($M = 44.0$, $SD = 13.0$) with their posttest scores ($M = 56.0$, $SD = 13.8$), a statistically significant correlation ($r = .61$, $p = .001$) was found. The fact that within each of the groups the pretest scores correlated significantly with the posttest scores might be worthy of noting for future investigation of the assigned conditions as possible predictor variables for success on the posttest.

Data Analyses

Research Question One

Research question one was, “To what extent did college algebra students using the MMT (Pearson Education, n.d.b) review treatment of prerequisite algebra skills demonstrate a significantly greater gain from pretest to posttest compared to those students who did not receive the review treatment?”

To answer this question, a 2 x 2 repeated measures ANOVA test was used. Because the pretest and posttest were the same, the data were used for the within-subjects factor of time, while the approach of group was used as the between-subjects factor. The test results indicated a significant difference for the main-effect factor of time, $F(1, 163) = 182.12$, $p = .001$. This means the pretest and posttest scores were significantly different for both groups of participants in this study. There were no statistically significant differences for the main-effect factor of group, $F(1, 163) = 0.016$, $p = .900$,

and no statistically significant interaction effect, $F(1, 163) = 1.262, p = .263$. When comparing pretest to posttest scores, no statistical differences were observed between the college algebra students using the MMT (Pearson Education, n.d.b) review treatment of prerequisite algebra skills and the control group. Thus, in this study, students using the MMT for a review of prerequisite skills during the first 4 weeks of a college algebra class did not have greater success on the posttest than those students who did not use the MMT review exercises of prerequisite skills.

Research Question Two

Research question two was, “To what extent did college algebra students using the MMT (Pearson Education, n.d.b) review treatment of prerequisite algebra skills show significantly higher achievement on the departmental final exam than those students who did not receive the review treatment?”

A one-way ANOVA test was used to analyze the data to answer this question. The results indicated the final exam scores of the two groups were not significantly different, $F(1, 163) = 0.012, p = .915$. Thus, in this study, students using the MMT (Pearson Education, n.d.b) to review prerequisite skills during the first four weeks of a college algebra class did not do significantly better on the department final exam than students who did not use the MMT review. As noted earlier in the table notes for Tables 4 and 5, final exam scores tend to be low as observed by the average exam score for all college algebra students before a curve was applied, $M = 55\%$, and the average exam score for the participants in the study, $M = 59\%$.

Research Question Three

Research question three was, “To what extent was the effect of students’ use of MMT (Pearson Education, n.d.b) on students’ performance on the departmental final exam the same for male students and female students?”

A 2 x 2 factorial ANOVA test was used in the analysis for answering Research Question 3. Results indicated there was no statistically significant interaction effect for gender and group, $F(1, 161) = 0.085, p = .771$, and neither was there a statistically significant main effect for gender, $F(1, 161) = 0.185, p = .668$, nor a statistically significant main effect for group, $F(1, 161) = 0.047, p = .829$. Presented in Table 6 is a comparison of the means and standard deviation for the final exam scores by gender and group.

Table 6

Final Exam Means and Standard Deviations by Gender and Group

Group	Students			
	Males		Females	
	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>
Treatment	57.88% (n=25)	15.60	59.79% (n=57)	13.89
Control	59.22% (n=27)	18.51	59.59% (n=56)	16.26

Thus, the use of MMT (Pearson Education, n.d.b) on students’ performance on the departmental final exam was similar for male students and female students.

Research Question Four

Research question four was, “To what extent was the effect of students’ use of MMT (Pearson Education, n.d.b) on students’ performance on the departmental final exam the same for students making their first attempt in a college algebra class and students making their second or later attempts in a college algebra class?”

The fourth research question examined whether there were differences between the final exam scores of students attempting the college algebra class for the first time and students attempting the college algebra class for a second (or more) time. A factorial ANOVA was used to test for differences between these groups using a 2 x 2 design. Findings indicated there was no statistically significant interaction between attempts and group, $F(1, 161) = 0.428, p = .514$. There were no significant differences for the main effect of attempts, $F(1, 161) = 0.767, p = .382$, and no significant differences for the main effect of group, $F(1, 161) = 0.358, p = .551$. Presented in Table 7 are the means and standard deviations for this data. While there were differences in the mean for group and attempts, the differences were not statistically significant.

Table 7

Final Exam Means and Standard Deviations for Number of Attempts by Group

Group	First attempt		More than one attempt	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Treatment	59.80 (n=74)	14.031	53.75 (n=73)	17.186
Control	59.58 (n=8)	17.458	58.70 (n=10)	12.885

Thus, the effect of students’ use of MMT (Pearson Education, n.d.b) on students’ performance on the departmental final exam was similar for students making their first

attempt in a college algebra class as it was for students making their second or additional attempts in a college algebra class.

Other Findings to Note

This research study tested just one possible factor thought to influence student achievement in college algebra, a review of prerequisite skills. Though the results did not indicate a statistically significant impact upon students' performance on the departmental final exam within the researcher's class, the researcher was able to collect data from USF that compared the performance of the students in the researcher's college algebra class to students enrolled in the other college algebra classes offered within the department. Noticeable differences in that comparison might potentially point to other factors that might have an impact on student performance. These data include the percentage of final exam pass rates among all college algebra classes as well as college algebra instructors' ratings as measured by student evaluations. This information might be important to know when considering factors an instructor can control such as his or her instructional strategies, teaching practices, and grading practices.

As presented in Table 8, a grade of 70% or higher is considered a passing grade on the departmental final exam. The researcher's class of over 200 students had a curved final exam pass rate of 71% while the average curved final exam pass rate for the other four instructors teaching classes with more than 200 students was 59%. In the smaller classes of less than 50 students, the average final exam pass rate was 62%. The results to the analysis of a Pearson chi-square test indicated the percentage of participants that

passed or failed the final exam did not differ by group (treatment or control), $\chi^2(2, n = 165) = 2.11, p = .35$.

Each semester at USF, students are asked to complete an evaluation of their instructors. It consists of eight questions rated on a scale of 1 to 5, where 5 is the highest. Student comments are optional. In addition to the college algebra final exam pass rates, presented in Table 8 are the mean instructor ratings for each of the college algebra instructors for fall semester 2010.

Table 8

Comparison of Final Exam Pass Rates and Students' Instructor Ratings, Fall 2010

Instructor	Final exam pass rate	Students' instructor ratings (1-5, 5 high)
Class > 200		
Researcher	71%	4.2
Instructor 1	61%	3.7
Instructor 2	53%	3.9
Instructor 3	69%	4.0
Instructor 4	52%	3.5
Class < 50		
Instructor 5	73%	3.6
Instructor 6	53%	3.8
Instructor 7	50%	3.6
Instructor 8	75%	3.6
Instructor 9	68%	3.7
Instructor 10	44%	2.5
Instructor 11	68%	3.2

Thus, of the five classes that had over 200 students, the researcher's class had the highest exam pass rate and the highest instructor rating produced by the students.

Besides comparing final exam pass rates between classes at USF, another measure of student performance for college algebra students was to compare the math department's student failure rates for fall semester 2010. The university considers a passing grade to be 70% or higher and considers grades below 70% (Ds and Fs) and students who withdraw (W) from the course before the grade consideration date to be failures. Presented in Table 9 is the researcher's college algebra class D-F-W failure rate as well as the overall department's college algebra failure rate. The researcher's fall 2010 failure rate is 10% lower than the department's failure rate.

Table 9

USF College Algebra Student Failures, Fall 2010

D-F-Ws by source	Fall 2010
Researcher	19%
Department	29%

Thus, the college algebra failure rate for fall 2010 when the research study took place was considerably lower in the researcher's section than found in the other course sections.

Though this research study indicated students using the review of college algebra prerequisite skills did not perform much differently than the other students within the researcher's college algebra class, the comparisons between the successes of the researcher's college algebra students and the other college algebra students in the department is worth noting. There is a possibility that the researcher's instructional strategies, teaching practices, and grading policy might have had an impact on her students' performance which was higher than other college algebra students in the

department as evidenced by the comparisons made in this chapter. The researcher's instructional strategies, teaching practices, and grading practices will be discussed in Chapter 5.

Summary

The purpose of the study was to learn if a prerequisite skill review given at the beginning of the semester concurrently with the normal sequence of course work would have a significant impact on the student's performance in the course. Analyses of the four research questions indicated that neither the review treatment, nor students' gender, nor number of times students attempted college algebra significantly influenced performance on the final exam. However, other findings noted in this chapter will be discussed in Chapter 5, along with some recommendations.

CHAPTER 5:

DISCUSSION

Introduction

A lack of readiness for college algebra may reduce a student's chance of completing a degree, and high failure rates in courses like college algebra affect a student's plan of study (Adelman, 1999; Burd & Boser, 2009; Gainen, 1995). Though an insufficient preparation in the prerequisite skills for college algebra can adversely affect success in the course, there are other variables—such as attitude toward mathematics, instructional practices, and math anxiety—that have been known to have an impact on success in mathematics (Aiken, 1970; Clute, 1984; Hopf, 2009; Sherman & Wither, 2003). Of these factors thought to influence success in mathematics, the primary focus of this study was to investigate whether an online prerequisite skills review presented at the start of a college algebra class along with the normal course work would have a significant impact on student achievement, as measured by a departmental final exam. Two other potential influences, gender and whether or not it was the student's first attempt at college algebra, were also examined. In this chapter, the study's findings will be discussed along with other factors noted in Chapter 4 that might influence student performance in college algebra. Some recommendations for both classroom instruction and future research are also presented.

Findings

The Research Questions

The study was conducted in the researcher's college algebra class during the fall 2010 semester at USF. It was guided by the following questions.

1. To what extent did college algebra students using the MMT (Pearson Education, n.d.b) review treatment of prerequisite algebra skills demonstrate a significantly greater gain from pretest to posttest compared to those students who did not receive the review treatment?
2. To what extent did college algebra students using the MMT (Pearson Education, n.d.b) review treatment of prerequisite algebra skills show significantly higher achievement on the departmental final exam than those students who did not receive the review treatment?
3. To what extent was the effect of students' use of MMT (Pearson Education, n.d.b) on students' performance on the departmental final exam the same for male students and female students?
4. To what extent was the effect of students' use of MMT (Pearson Education, n.d.b) on students' performance on the departmental final exam the same for students making their first attempt in a college algebra class and students making their second or later attempts in a college algebra class?

The analyses of the data for research question one did not indicate a significant difference in the treatment group and control group when comparing their pretest to posttest scores. Change from the pretest to the posttest was not greater for students using MMT (Pearson Education, n.d.b) for a review of prerequisite skills than those students who did not use the MMT review. Research question two when analyzed resulted in no statistically significant differences in the final exam scores between the two groups. Students using the MMT (Pearson Education, n.d.b) for a review of prerequisite skills did not have greater success on the department final exam than those students who did not use the MMT review. In reviewing the literature, it was noted there were no experimentally

designed studies that have been conducted to determine if a review of the college algebra prerequisite skills would significantly influence achievement in college algebra.

While states are looking for solutions for improving the success of students in entry-level math courses such as college algebra, the intervention used in this study did not have a significant impact on student performance. The analysis of the data for research questions one and two indicated students who completed the treatment review of prerequisite skills for the first four weeks of the semester and students who did an extra problem set based upon their current course work for the first four weeks of the semester performed similarly on both the posttest as well as the departmental final exam. With as many as 25% or more of entering college freshmen needing to take remedial math courses, alternative solutions for preparing students for college entry-level math must be pursued (Merisotis & Phipps, 2000). It was proposed by Burke (2009) that providing students with an intensive online review of prerequisite college algebra skills immediately prior to the semester in which college algebra was to be taken might be a way to improve student success. It has been noted in the literature that commercial online programs are becoming more commonly accepted by faculty and available due to their relative low cost, convenience, and ability to closely align instruction with the individual student's needs (Hopf, 2009; Sperling, 2009).

For research question three, results indicated there was no interaction between group and gender as well as no main effect for gender on the final exam and no main effect for group. There was no evidence that the treatment effects were different for males and females. While Bridgeman and Wendler (1991) indicated female students'

grade averages tend to be equal to or slightly higher than male students' grade averages when comparing gender to college math achievement, in a more recent study, Little (2002), found gender to be fourth of seven variables that significantly aided success in introductory algebra. The findings of this study do not support either of the previous two studies and the literature has inconsistent findings regarding the effect of a student's gender on success in a math course. Thus, for expanding the literature, this research can support the fact that online review treatment effects were no different for males and females.

Upon analysis of research question four, the findings indicated there was no statistically significant interaction between attempts and group and there were no significant main effects for attempts or group. Though there is a gap in the literature regarding the success of first-attempt students in college algebra, Hopf (2009) noted that students making their first-attempt at college algebra had 25% higher success rates in passing a college algebra course than those students with prior attempts. While this study did not indicate significant effects for first-attempt college algebra students on student achievement, it does contribute to the scant literature on the subject.

Other Factors to Consider

Based upon the present findings, a lack of prerequisite skills for college algebra may not be the primary reason why large numbers of students fail the course. Other factors beyond the research questions explored in the present study might have influenced student success in college algebra. Several are identified in Figure 4. Of the six factors included in this diagram, three are influenced by the instructor—specific instructional

strategies, general teaching practices, and grading practices –while the other three are influenced by the student—math anxiety, attitude toward mathematics, and personal life situations.

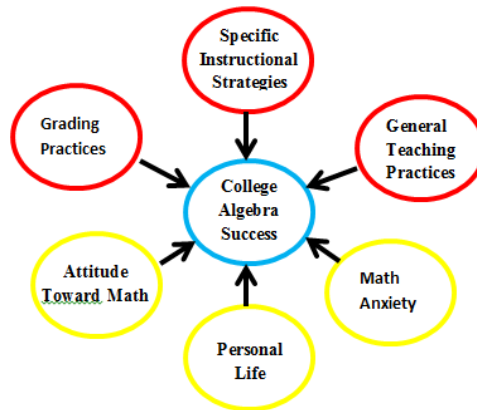


Figure 4. Factors that might have an impact on college algebra success.

Though findings of this study did not demonstrate that reviewing prerequisite college algebra skills enhanced student performance, the researcher’s students did have higher performance measures than other college algebra students in the department. The researcher’s college algebra class had higher departmental final exam pass rates than the other five college algebra classes enrolling over 200 students and a 10% less D-F-W failure rate than those of the other course sections as noted in Chapter 4 after observing Table 8 and Table 9. Teaching practices such as instructional strategies (e.g., direct instruction or interactive instruction) and grading practices have been found to be significantly related to higher achievement in student performance (Schwerdt & Wuppermann, 2008).

Instructional strategies. It might be illuminating to look further at other factors of the researcher’s classroom practices as possibly having influenced her students’

performance, though not necessarily a cause-and-effect type of influence. The approach an instructor uses to facilitate student learning can be considered an instructional teaching strategy or method and the two mentioned here were incorporated in the researcher's present teaching strategies—direct instruction and interactive instruction. In a meta-analysis of teaching methods that enhance secondary algebra achievement, one of the top six categories determined as some of the more effective methods was direct instruction (Haas, 2005). In that study direct instruction was described as, “Establishing a direction and rationale for learning by relating new concepts to previous learning, leading students through a specified sequence of instructions based on predetermined steps that introduce and reinforce a concept, and providing students with practice and feedback relative to how well they are doing” (p.28). Teaching methods that engage the student in active learning are part of interactive instruction. Students should do more than just listen to a lecture; they should be actively involved in solving problems, have reflective discussions, and use higher levels of thinking (Bonwell & Eison, 1991). While these practices described by Haas were employed by the researcher as part of her instructional strategies, they were not the primary focus of this research nor is it known whether other college algebra instructors in the department used these strategies. However, future research might investigate some of these practices. For that purpose, a brief summary of two instructional strategies and how the researcher used them in the instruction of the college algebra class used for this research study is presented in Table 10.

Table 10

Summary of Researcher's Instructional Strategies

Strategy	Description	Researcher's use
Direct instruction	Relates new concepts to previous learning	Structured overview in lecture with MLP online review quizzes
	Provides student with practice and feedback	Students reply to lecture questions with response pad (clickers) and get immediate feedback on MLP online homework
	Helps develop step-by-step skills	Weekly lectures, PowerPoint notes, and worksheets with models of step-by-step examples
Interactive instruction	Relies on discussion and sharing	Reflective group discussions in lecture
	Uses groups/various interactive methods	Think-pair-share activities in lecture
	Students learn from peers and teacher	Required worksheets can be completed collaboratively with peers and teaching assistant

Teaching practices. For decades, various segments of society have sought to identify and employ best practices to improve customer satisfaction. The concept of best practices in higher education was made popular by Chickering and Gamson (1987) when they introduced their seven principles of good practice in teaching based on years of research on how instructors teach and how students learn. The seven principles include the following.

- Encourages student/faculty contact
- Encourages cooperation among students
- Uses active learning techniques

- Gives prompt feedback
- Emphasizes time on task
- Communicates high expectations
- Respects diverse talents and ways of learning

The researcher notes that in her own experience, practicing the seven principles promotes satisfied student learners who are more willing and motivated to persevere to complete their assignments.

Grading practices. Yet another factor that may have influenced student performance in the researcher's class was how the grading practices were conducted. Grades are commonly used to provide information on how well students are learning but can also be used to inform the instructor about what students have and have not learned, to stimulate and encourage good work by students, and to improve the student's self-evaluation for work submitted. There are no set rules about the best way to grade, and how an instructor grades depends largely on values, assumptions, and educational philosophy (Erickson & Strommer, 1991). Instructors teaching college algebra at USF are required to count the departmental final exam as 25% of the overall course grade; the remaining 75% of the course grade is left to each instructor's individual discretion. For a USF student to receive credit for college algebra, he or she must receive an A, B, or C as their final course grade. Anyone making a grade of D or F, or withdrawing from the course without grade consideration, is considered a failure. The fact that the researcher's college algebra class D-F-W failure rate was 19% while the overall failure rate of the college algebra classes in the department was 29% was also noted in Chapter 4. Because

75% of each student's grade is determined by his or her instructor, there is a chance that some of this variability in grades within the department might be attributed to an interaction effect of the review treatment used in the research and the researcher's specific grading practices.

To assist in developing clear guidelines for a grading policy, Davis (1995), in her book, *Teaching Tools*, suggested several grading strategies that were also used by the researcher in developing her grading policy. Though the grading practices used by the researcher were not the focus of this research, they may have influenced student achievement. To assist future research that might investigate whether grading practices affect student performance, some of the detail of how the researcher implemented them in the grading policy for her college algebra class are presented in Table 11.

Table 11

Grading Practices Used in Researcher's College Algebra Class

Grading strategy	Researcher's implementation
1. Clearly state grading procedure.	Policy written in course syllabus; students took a mandatory quiz on syllabus contents.
2. Grade on basis of students' mastery of knowledge and skills.	94% of grade restricted to academic performance of homework, quizzes, tests.
3. Provide enough opportunities for students to show what they know.	24% of grade based on 19 homework assignments and 33 quizzes; 6% of grade based on lecture and lab class participation (attendance/daily grades).
4. Give students a chance to improve grade.	4 lowest of 19 homework's dropped and 6 lowest of 33 quizzes dropped; comprehensive final exam replaced lowest test score if it was higher.
5. Keep students informed of their progress.	Online homework/quizzes with immediate feedback of accuracy and grade; weekly updated account of overall weighted grade

	kept in online grade book accessed by students.
6. Give encouragement to students performing poorly and praise to students performing well.	Students were periodically sent e-mails regarding their progress; extra help was provided in the lab.

Recommendations

Recommendations for Future Research

Generalizability. It was noted in Chapter 1 that conducting this study at one institution limits the generalizability of its findings and the results of the present study might not be representative of those that might be obtained on other campuses. The potential for greater generalizability could be improved by replicating this study on one or more other campuses.

Aspect of the Design. In this experimental study, a pretest-posttest design was used to compare the participants in the two groups and measure the degree of change on the prerequisite skills and the subsequent performance on the final exam. Haas (2005) noted in his meta-analysis of 35 experimental research studies, the treatment group received a specific teaching method as the treatment and the control group did not necessarily receive any condition. In this study, the treatment group received the review of prerequisite college algebra skills and the control group received an extra problem set of current algebra work. Both groups received extra math work to do in addition to their normal course work. Because both groups were doing extra math work, this may have confounded the ability to observe an overall effectiveness of the treatment condition. Thus, a replication of this study using three groups instead of two, where the first group

gets the review treatment condition, the second group gets the extra algebra problem set, and the third group gets no extra algebra work, may provide further insight into the effectiveness of reviews and extra algebra work on student performance in college algebra. Such a study might reveal that not just a review of prerequisite course skills may have an impact on student achievement but any extra math work completed in addition to the normal course assignments will enhance student performance in the course.

Intensify Intervention. Though there has been no prior research that specifically studied the impact of a prerequisite skills review at the start of a college algebra course, Burke (2009), in a non-experimentally designed investigation, noted that students using the online program, ALEKS (n.d.), for an intensive 3-week review of basic algebra skills during the summer prior to the fall semester did have higher pass rates than those students who did not complete the intensive 3-week review. There was no control group in Burke's study and students had the potential of using the ALEKS (n.d.) program for 45 hours. In the present research study, students in the review treatment condition reviewed the prerequisite skills material during the first 4 weeks of the semester for approximately 12 hours, in addition to their normal college algebra assignments while the control group did a supplemental practice set of exercises on the normal course requirements. In short, both groups were doing extra practice to supplement the regular class work. It is possible that 12 hours of review time was not sufficient for students to develop mastery-level learning of the prerequisite college algebra skills and this review did not have a significant impact on student performance at the end of the semester. Thus, it is suggested that a replication of this study incorporating an increased use of the online review

program over a longer period of time may reveal evidence that such a review would have a significant impact on student achievement in college algebra.

Self-Efficacy. As noted earlier in this chapter some factors motivating success in college algebra are controlled by the student such as attitude toward mathematics and math anxiety. The literature regarding attitude toward mathematics indicated a small consensus and low correlations between attitude toward math and achievement (Evans, 2007; Ma & Kishor, 1997). While math anxiety was mentioned in the literature as a factor that has been known to influence success in math, the studies varied on how significantly math anxiety affected math achievement (Sherman & Winter, 2003). The lack of consistent findings about factors controlled by the student such as attitude toward mathematics and math anxiety suggests the need for future studies regarding these two factors and the extent to which they may influence math achievement. A qualitative study is suggested using interviews, surveys, and focus groups as a means to expand the understanding of the factors influencing performance in college algebra that are controlled by the student.

Instructional Strategies. This research study examined one factor that may influence student performance in college algebra, namely the use of an online review of prerequisite skills. Other potential factors have been discussed in this chapter. It might be helpful to investigate whether either one or both of the instructional strategies (direct instruction and interactive instruction) used by the researcher could have an impact on student performance. Future research might look for an interaction effect between a review of prerequisite skills and specific instructional practices. Such a study might

reveal findings that support the literature regarding whether engaging the learner in active learning as opposed to just lecture classes may influence student performance.

Teaching Practices. As mentioned before, one of the factors controlled by the instructor that affects student learning is the practice of using the seven teaching principles (encourages student/faculty contact, encourages cooperation among students, uses active learning techniques, gives prompt feedback, emphasizes time on task, communicates high expectations, and respects diverse talents and ways of learning) while conducting class instruction (Chickering & Gamson, 1987). An experimental research design is suggested for future studies regarding the effectiveness of the instructor's good teaching practices where both the treatment and control group would get the review of prerequisite college algebra skills but only the treatment group would receive intense levels of the seven principles of good teaching practice. This study could have a qualitative component that might include a student survey with questions based on these seven principles of good teaching practice, followed by student interviews. Research measuring the effectiveness of how an instructor teaches using some, all, or none of the seven principles of best practices might lead to improvement in learner satisfaction which may ultimately have an impact on student achievement.

Grading Practices. Another factor controlled by the instructor, which varies among instructors and depends on the instructor's values, assumptions, and educational philosophy, is the grading practices (Erickson & Strommer, 1991). Arum and Roksa (2011) suggested that institutions can improve student learning by making sure there is some consistency in the course requirements. In subsequent studies grading policies and

the amount of required work might be looked at in depth to see if conformity to course requirements and weighted grade distribution by all college algebra instructors might have a positive effect on student performance. Thus, it is suggested that future research regarding grading practices might be carried out in two ways: a study that compares the various grading practices within a college algebra class with student achievement, and a study that measures how consistency of the college algebra grading policy between college algebra courses in the department influences student achievement.

Recommendations for Classroom Instruction

As discussed in this chapter, there were other factors controlled by the instructor and by the student that might have influenced student performance in the researcher's college algebra class. Though students' use of the prerequisite review treatment in the researcher's college algebra class did not produce higher scores on the departmental final exam than those produced by students who did not complete the review treatment, the researcher's students did perform better on the departmental final exam than the students in the other college algebra classes in the department. However, the fact that both the treatment and control groups received extra practice exercises beyond the regular class requirements which other college algebra students in the department did not receive, might support increasing the amount of required college algebra practice exercises.

Recommendations for the Institution

Student success is vitally important to institutions of higher learning; this means retaining students and supporting them to graduation. Three main areas are key in this endeavor—campus climate, academic preparedness of the student, and the classroom

experience. While instructors and researchers have little influence over the campus climate, in general, instructors can research and implement new ways to improve the climate within the classes they teach. With respect to student placement into appropriate course work, the researcher believes that it is the institution's role to assess the students' level of preparation for college algebra and then advise the students as to which course to enroll so that they are most likely to be successful. To this end, the researcher makes the following suggestions for placement assessment and academic advising:

- Placement assessment: Many institutions like USF use one criterion, such as an SAT or ACT test score to determine a student's placement into a math course unless the student takes and passes a prerequisite course. It is suggested that institutions who use a single test score for course placement investigate alternatives to that practice which might include additional assessment measures. One possibility might be to investigate whether a placement test similar to the pretest used in this study might result in a more reliable predictor of course success.
- Advising students: With limited information on what might be the best predictor of student success in a course, advising a student is difficult at best. One of the results of this study indicated that 22% of the variance in the final exam scores for college algebra could be accounted for by student posttest scores. It is suggested that institutions with limited information on best predictors for college math success make it a priority to conduct research that would study ways to reliably predict student success in college algebra.

Conclusion

Primarily, the purpose of this study was to determine whether a review of prerequisite skills at the start of a college algebra course would have a significant impact on student algebra achievement. Because the prerequisite review treatment did not appear to significantly influence student performance, it would be important to investigate other factors that may have a positive impact on learning. Students in the research study class performed better than the other college algebra classes on the departmental final exam. It

is possible that students performed better because they knew they were being studied and maybe knowingly or unknowingly worked harder than they would have had they not participated in the study. There are variables that drive human behaviors that may have nothing to do with the design of the study but just the fact that they are in a study. When there is an experimental effect in a study but not for the reasons expected, it is known as the Hawthorne effect (Franke & Kaul, 1978).

Though participants in this study were given specific requirements on when and how they were to complete the online review treatment program or the online alternate set of exercises, the way the students carried out that requirement may have influenced the outcome in this experiment. To ensure treatment fidelity, a bonus grade was given to each participant based on a grading rubric that identified the time spent and the grades received for completing the work. While the participants' average bonus grade was 80%, there are various ways the work may have been completed without the student receiving the full benefit of the instruction.

It is also possible that the researcher, as the instructor in the classroom in which the study took place, may have influenced the students' performance by her teaching strategies and attention to student learning-centered curriculum. The bar was not dropped so as to compromise the standards of the class and students were routinely encouraged to do their best with personal e-mails, help sessions, and open communication. As one student stated, "The instructor makes everything fairly simple, not trying to fail the student per say [*sic*] but makes it a way for everyone to succeed if you do everything asked of you." Further study regarding other factors that positively influence student

performance is needed. Knowing what factors significantly contribute to improve student performance could be important to students, faculty, and the institution in keeping costs to a minimum and at the same time increasing the number of students who can proceed with their plan of study and ultimately complete their college degree.

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APPENDICES

Appendix A: University of South Florida Math Course Prerequisites

Course	Prerequisites
Finite mathematics (MGF 1106) Math for liberal arts (MGF 1107) Basic statistics (STA 1022)	C or better in intermediate algebra or 440+ SAT-M or 19+ ACT-M or 72+ elementary algebra CPT
College algebra (MAC 1105)	C or better in intermediate algebra or 490+ SAT-M or 21+ ACT-M or 90+ elementary algebra CPT or 40+ college-level math CPT
Precalculus algebra (MAC 1140) Precalculus trigonometry (MAC 1114) Precalculus algebra & trigonometry (MAC 1147)	C or better in college algebra or 550+ SAT-M or 24+ ACT-M
Business calculus (MAC 2233)	C or better in college algebra and/or trigonometry or 590+ SAT-M or 26+ ACT-M or 78+ college-level math CPT
Life science calculus (MAC 2241) Engineering calculus (MAC 2281) Calculus I (MAC 2311)	C or better in college algebra and/or trigonometry or 650+ SAT-M or 29+ ACT-M or 90+ college-level math CPT

Note. Adapted from University of South Florida (n.d.b).

Appendix B: University of South Florida Average Failure Rate 37.6%,

Fall 2005-2008

Fall 2005 average failure rate 41%						
Sect	Sect	Sect	Sect	Sect	Sect	Sect
21-28	31-38	41-49	51-57	91-96	799	901-908
33%	46%	42%	32%	32%	59%	56%

2006						
Spring 2006 average failure rate 48%						
Sect	Sect	Sect	Sect	Sect	Sect	Sect
11-18	21-28	31-38	799	908		
54%	39%	51%	66%	46%		

Summer 2006 average failure rate 31%						
Sect 1-12						
31%						

Fall 2006 average failure rate 43%						
Sect	Sect	Sect	Sect	Sect	Sect	Sect
11-16	21-26	31-36	41-47	51-56	799	901-906
58%	35%	29%	58%	45%	52%	29%

USF failure rate											
Spring 2007 average failure rate 45 %						Summer 2007 average failure rate 38%					
	Sect	Sect	Sect	Sect	Sect	Fall 2007 average failure rate 38%					
21-28	21-28	31-38	41-48	799	908	Sect	Sect	Sect	Sect	Sect	Sect
44%	40%	48%	63%	43%		11-18	21-26	31-38	41-49	799	908
						53%	31%	46%	23%	64%	35%
2008											
Spring 2008 average failure rate 36%						Summer 2008 average failure rate 24%					
	Sect	Sect	Sect	Sect	Sect	Fall 2008 average failure rate 32%					
11-18	21-27	31-37	799	908		Sect	Sect	Sect	Sect	Sect	Sect
43%	27%	33%	50%	38%		11-18	21-28	31-38	41-48	91	799
						45%	26%	27%	25%	44%	41%

Appendix C: Study One Results

“Study One” Results by Fran Hopf (2009)

During the fall semester of 2009, the researcher conducted a pilot study in a college algebra lecture class at USF, which incorporated two online review programs as a means for students in the course to review the prerequisite skills. Of the 219 students attending the first day of class, 90% voluntarily participated in the study. They were randomly assigned to one of three groups: a group using ALEKS, an online review program; a group using MMT, an online review program; or the control group, with no online review. The students assigned to the online reviews were asked to complete a minimum of 4 hours review each week for 4 weeks in those treatment programs. The students assigned to the control group had no review but instead were required to complete a written paper of comparable time and intensity as the online review treatment work. This assignment ran concurrently with the normal course of study and homework being conducted in the lecture class. The participants took a pretest on the second day of class and a posttest at the end of the 4 weeks of online review. The change score between the pretest and posttest was used as the measurement for the three levels of the independent variable: the group assignment. At the end of the semester, the change scores were compared to the departmental final exam scores and the final course grades.

Presented in Table C.1, Group Mean Average Grades, are the number of participants in each of the three treatment levels and each group's mean averages for the final course grade, the departmental final exam grade, the pretest-posttest change score, and the hours spent on the treatment. The last two columns of the table present the

success rate for each group with respect to the departmental final exam and the final course grade. The analysis did not indicate a significant difference in the passing success between the review treatment groups and the control group. By a small margin, the MyMathTest group did outperform the control group and the ALEKS group when comparing the mean averages for course grade and exam grade.

Table C.1

Group Mean Average Grades

Group	Orig <i>n</i>	Last <i>n</i>	Mean course grade	Mean exam grade	Mean pre/post-chg score	Mean hrs. on treatment	Exam passing rate	Course grade passing rate
A—ALEKS	71	64	71.2	68.3	6.5	11.9	63%	63%
C—Control	66	60	71.7	68.2	1.1		67%	68%
M—MMT	70	61	74.8	71.9	5.9	12.8	69%	74%

Though unpreparedness in the prerequisite skills for college algebra can have an impact on success in the course, there are other external factors to consider. Some studies have indicated variables such as high school math grade average, highest high school math course taken, and gender as having the potential to significantly influence success in college algebra (Adelman, 1999; Horton, 1998; Johnson, 1996; Little, 2002). Factors such as whether it is the student's first attempt at college algebra or whether students have had 1 or more years elapse since taking their last math course are of particular interest to the researcher. However, there is little mentioned about these two factors in the literature. To collect data for these factors, the participants in the pilot study were asked to complete a self-report survey during the first week of the semester.

The five external factors surveyed were (a) gender, (b) first attempt at college algebra, (c) highest level of high school math course taken, (d) high school math grade average, and (e) time elapsed since the last math course was taken. A summary of the results of the self-report survey is shown in tables C.2-C.6. While the passing rates varied only slightly for the highest level of high school math course taken and the time elapsed since the last math course was taken, the other three survey questions did result in greater variations. The passing rate for female students was 31% higher than for male students. Of those students making their first attempt at college algebra, 72% passed, as compared with 47% of the students making at least their second attempt. Approximately 70% of those students with an A or B average high school math grade passed the course as compared to 52% passing of those students with a C average high school math grade.

Table C.2

Gender

Gender	Male	Female	Did not answer
Percent	32%	66%	2%
Passed exam	53%	72%	
Passed course	47%	78%	

Table C.3

First Attempt

First Attempt	Yes	No	Did not answer
Percent	89%	9%	2%
Passed exam	66%	56%	
Passed course	72%	47%	

Table C.4

Highest Level of High School Math Course Taken

Highest HS math course passed	Alg 1	Geom	Alg 2	Math analysis	Other	Did not answer
Percent	1.50%	0.50%	24%	9%	63%	2%
Passed exam	67%	100%	62%	75%	66%	
Passed course	67%	0%	67%	69%	68%	

Table C.5

High School Math Grade Average

HS math GPA	A avg	B avg	C avg	D avg	F avg	Did not answer
Percent	25%	62%	11%			2%
Passed exam	72%	46%	48%			
Passed course	67%	71%	52%			

Table C.6

Time Elapsed Since Last Math Course Taken

Time elapsed since last math course	< 1 yr	1 yr	2 yrs	3 yrs	≥ 4 yrs	Did not answer
Percent	63%	25%	8%	0%	2%	2%
Passed exam	63%	68%	71%		67%	
Passed course	68%	72%	64%	0%	67%	

In this study, the results indicated that external factors, such as using the MMT online review program, having an A or B average high school math grade, or being a female student, may influence students' success in college algebra. In light of the fact that

there are a large number of students nationally and locally who fail college algebra, the researcher conducted a further study regarding this problem. Restricting the number of potential majors a student might pursue by virtue of having failed a few college math courses stands in opposition to the goal of most educators and postsecondary institutions. The need to consider incorporating changes in entry-level college courses such as college algebra with the objective of improving the likelihood of success for the underprepared student is underscored by these statistics. An intensive short-term review at the start of a college algebra course could have a positive impact on the student's success in the course and eliminate the need for a full-semester remedial course or the possibility of multiple repeats of the course due to failure.

Appendix D: Course Syllabus

COLLEGE ALGEBRA
MAC 1105 Sections 41-48
3 Credit Hours

Course Syllabus

Fall 2010

This course is part of the University of South Florida's Foundations of Knowledge and Learning Core Curriculum. It is certified for mathematics and quantitative reasoning and for the following dimensions: critical thinking, inquiry-based learning, scientific process, and quantitative literacy. Students enrolled in this course will be expected to participate in the USF General Education assessment effort. This might involve answering questions that measure quantitative reasoning skills (but are not directly related to the course), responding to surveys, or participating in other measurements designed to assess the FKL Core Curriculum learning outcomes.

Instructor

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Office – PHY 306 Hours: Mon (2-3) & Wed (11-12)

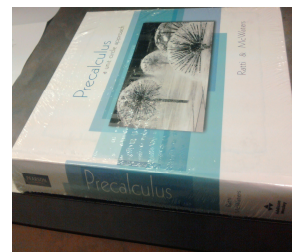
Required Textbook & Supplemental Resources

1. *Precalculus Algebra*, by Ratti and McWaters

Same textbook as other classes

Different online program—

MyMathLab “Plus”



2. MyMathLabPlus (online homework). To register you will need the access code which is in the booklet that comes shrink-wrapped with the

purchase of a new textbook from the USF bookstore. If you have a used book you can purchase the MyMathLabPlus code with a credit card during the registration process or by buying a prepaid registration at the bookstore.

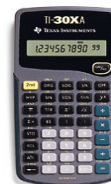
3. Classroom Performance System (CPS). All students will be required to purchase a wireless remote pad better known as a “clicker.” In addition to purchasing the clicker, a registration fee will be required which can be made with a credit card during the registration process or by buying a prepaid registration at the bookstore. The registration process begins at the Blackboard



Course Tools link by selecting CPS.

4. Calculator - TI-30 XA

The only calculator permitted is this model. NO OTHER MODEL CALCULATORS ARE PERMITTED. Calculators may not be shared during quizzes, tests, or the final exam. You are not allowed to use a cell phone as a calculator. Cell phones must be turned off and out of visual sight for all classes and tests.



Prerequisites

C (2.0) or better in MAT 1033, or SAT Math score of 490 or better, or ACT Math score of 21 or better, or Elementary Algebra CPT score of 90 or better, or College-Level Math CPT score of 40 or better.

Computer Requirements

Must have Internet access (preferably a high-speed connection). Your computer must be at least a 500MH processor with the necessary java plug-ins. You can use the Browser Wizard on the USF Academic Computing site (<https://my.usf.edu>) to verify that you have the necessary plug-ins.

Technical Requirements

Be able to work with the following hardware applications on a PC:

- Save files
- Locate files
- Register for online resources
- Add plug ins
- Problem solve technology issues
- Contact and work with Technology help desk personnel

Be familiar with the following types of software:

- Web browser
- Blackboard
- Search engine
- E-mail
- Discussion boards

Gordon Rule/General Education

This course fulfills 3 hours of the Gordon rule computation requirement and also 3 hours of the general education quantitative methods requirement, provided a grade of C or

better is achieved. If this course is used as a requirement for a follow-up course, then a grade of C or better must be earned.

Course Description

Mathematical modeling of real-life applications. Concepts of the real number system, functions, graphs, and complex numbers. Analytic skills for solving linear, quadratic, polynomial, exponential, and logarithmic equations.

Primary Learning Goals

Teach basic skills and concepts of algebra that will be required for calculus.

Course Objectives

Knowledge:

1. Students will understand and apply the appropriate sequence of steps necessary to solve a wide range of equations, including linear, quadratic, factorable-polynomial, radical, exponential, and logarithmic equations.
2. Students will understand, apply, and explain the concepts and practical uses of a “relation” and “function.”
3. Students will understand, construct, and interpret graphs in the Cartesian plane, including polynomial functions, rational functions, exponential functions, and logarithmic functions.
4. Students will understand, apply, and interpret the graphs of functions using knowledge of transformations.
5. Students will understand, write, and describe how to perform operations with functions and composition of functions.
6. Students will understand, interpret, and explain the outcome when solving applications involving functions such as polynomial, rational, logarithmic, and exponential functions.
7. Students will understand and apply the appropriate sequence of steps necessary to solve systems of equations and inequalities and interpret their solution sets.

Skills:

Students will develop skills in the following areas:

1. Critical thinking

2. Inquiry-based learning
3. Problem-solving
4. Self-assessment
5. Communication

STUDENT OUTCOMES:

Students successfully completing MAC 1105 will

1. in Knowledge Objective 1 and Knowledge Objective 7, be able to correctly apply the appropriate *sequence of steps* necessary to solve equations, including linear, quadratic, factorable-polynomial, radical, exponential, and logarithmic equations and to solve systems of equations and inequalities.

For Example: Given the exponential equation, $2^x = 4^{2x+1}$, the student will be able to solve for x by first rewriting both sides as powers of the same base.

2. in Knowledge Objective 2 and Knowledge Objective 6, be able to *explain* the concepts, uses, and applications of relations and functions including polynomial, rational, logarithmic, and exponential functions.

For Example: Given the following application of a function, the student will be able to write a function rule and find and explain $A(4)$. “The area $A(x)$ of a square tile is a function of the length x of a side of the square.”

3. in Knowledge Objective 3 and Knowledge Objective 4, be able to *interpret* graphs in the Cartesian plane and graphs of functions using knowledge of transformations.

For Example: Given the cost function of a product is $C = 625 - 50x + x^2$, the student will be able to sketch the graph of the function, interpret whether there is a maximum or minimum, and find the value of x for which the maximum or minimum occurs.

4. in Knowledge Objective 5, be able to *describe* how to add, subtract, multiply, and divide two functions and describe how to write a composite function.

For Example: Given $f(x) = x - 3$ and $g(x) = 3x - 5$, the student will be able to describe how to find $(f \circ g)(x)$ and $(g \circ f)(x)$ and determine if they are the same.

5. in Skill Objective 1, be able to *apply* critical thinking when interpreting the results to the calculations of the formulas associated with the topics in this course.

For Example: When solving a problem involving compound interest, the student will be able to determine the appropriate formula, know what information is necessary to solve the problem, and then correctly interpret the results.

6. in Skill Objective 2 and Skill Objective 3, be able to *identify* and use the steps necessary for inquiry and appropriate problem-solving techniques when solving applications involving the topics in this course.

For Example: Given the following problem to solve involving trash composition, the student will be able to identify the appropriate steps for solving the problem by writing and solving a system of equations. “Paper and plastic together account for 48% (by weight) of the total trash collected. If the weight of paper trash collected is five times the weight of plastic trash, what percent of the total trash collected is paper and what percent is plastic?”

7. in Skill Objective 4, be able to *identify* what they have learned and what they are still unsure of in the various topics of this course.

For Example: Given the topic “rational functions,” the student will be able to write a one-minute paper outlining some of the characteristics (like intercepts and asymptotes) necessary to sketch the graph of a rational function and name some of the concepts of the graph (like behavior close to the asymptote) they still don’t comprehend.

8. in Skill Objective 5, be able to *explain* both in written and oral form the processes associated with solving applications in this course.

For Example: Given a set of linearly related data, the student will be able to use the information to construct the graph of the data, find the value of the slope of the line, and explain the meaning of the slope of the line as it relates to that information in both written and oral formats.

Class Meeting Times:

Lecture Classes – meet Monday/Wednesday in ENA 105 at 3:05-4:20 pm

Interactive Learning Session – meets Friday in ENA 105 at 9:40-10:55 am

Course Design:

Lecture Class: Meets twice a week for 75 min. each time. The lecture instructor will do the following:

1. Present the course material and post class notes on Blackboard;
2. Practice problems with students;

3. Administer class participation problems, which students will respond to by using their clickers.

Interactive Learning Session: Meets once a week for 75 min. The lecture instructor assisted by the graduate teaching assistants will do the following:

1. Answer homework questions from the textbook and the online homework;
2. Facilitate completion of worksheets in groups or individually;
3. Administer quizzes, which students will respond to by using their clickers.

Online Graded Homework: All students will be required to complete and submit weekly homework assignments via an online program called MyMathLabPlus (MLP). It is linked on your Blackboard course site and can also be accessed from the Blackboard Tools link.

All Students in the Class Are Expected to:

1. Attend all lecture classes, Friday interactive sessions, and exams.
2. Spend at least 9 hours per week reading, practicing, studying, and discussing this course.
3. Take an attitude survey at the start and the end of the semester. It will not be counted as a grade.
4. Take a pretest of college algebra prerequisite skills on the first class day of the semester.
5. Take a posttest of college algebra prerequisite skills at the end of the first 4 weeks of the semester.
6. Take three chapter tests (worth 15% each test) that will be made up of multiple choice questions for which there will be NO MAKE-UP OR RETAKE TESTS GIVEN. Any missed test, whether due to excused or unexcused absence, will be an automatic “0” grade and can be replaced with your bonus grade (explained below).
7. Take a 2-hour departmental final exam (worth 25%) that will be cumulative with *all* questions being multiple-choice. The date and time for this exam are Monday, Dec. 6, 3:00 p.m. to 5:00 p.m (see note below about time conflicts). Your instructor will notify you of its location.

Time conflicts with the scheduled final exam time:

- Students who normally work during the scheduled time of the final exam are expected to make arrangements with their employer to get time off.
- Students who have another common final exam scheduled during this same time period that has higher priority in USF’s exam conflict policy will be permitted to take a makeup. You must submit proof that such a conflict exists.

- Students who miss the final exam for any other reason should *not* expect to be given a make-up exam.
8. Complete online graded homework at MMLP (worth 15%). You must complete the assigned problems from the sections listed by the due date as specified on the semester schedule below. You may have three attempts at each homework question. If you miss a question more than two times, it is highly recommended that you seek tutoring at the Math Center in LIB 206. The grade will be the best attempt. There will be 22 assignments. The lowest four grades will be dropped. Thus, NO MAKE-UPS for any reason. No late work accepted.
 9. Participate in the lecture class (worth 5%) by responding to questions posed by the instructor using a clicker (remote wireless responder). This activity will be counted as a grade beginning the third week of class. The lowest four grades will be dropped. Thus, NO MAKE-UPS for any reason, including absence and/or technical issues.
 10. Take quizzes (worth 5%) in Friday interactive sessions that will be composed of five questions pertaining to the course objectives taught that week in the lecture classes. The quizzes will be completed with the clickers. The four lowest grades will be dropped. Thus, NO MAKE-UPS for any reason.
 11. Complete a weekly, 15-question online worksheet at MLP at the worksheet link (worth 5%). The worksheet will become available on Mondays at 5:00 p.m. and will be due by 9:00 a.m. on Fridays. You may have multiple attempts at each problem. The four lowest grades will be dropped. Thus, NO MAKE-UPS for any reason.
 12. Have the option to complete a bonus grade assignment (worth 15%, which can replace your lowest chapter test grade if it is higher) over the first 4 weeks of the semester. This will be one of two assignments—either 12 hours working in an online review program MyMathTest (MMT) or 12 hours working on additional exercises from the course content (explained below).

* Extra Credit (3%)

Students may complete the practice final exam given in lecture class on Wednesday/Dec. 1, for extra credit. The questions from that exam will be reviewed in the Friday class following the test.

Bonus Grade – MAY BE USED TO REPLACE LOWEST TEST GRADE

In addition to the normal sequence of course work, over the first 4 weeks of the semester, all students will be given the opportunity to complete an additional 12 hours of work (3 hours weekly for 4 weeks) in one of two assignments referred to as the treatment group or the control group. This bonus grade may be used to replace your lowest test grade if it is higher.

This semester, a research study will be conducted in this class, and you are invited to voluntarily take part. The study is entitled “The Impact of a Short-Term Review Treatment Program on Student Success in a College Algebra Course.” This study will be under the direction of your instructor. The purpose of this study is to assess whether completing a short-term online review of prerequisite college algebra skills at the start of a college algebra course will increase students’ success compared to students who do not receive the review.

Participants in the research study will be randomly assigned to one of two assignments—the treatment group or the control group.

Nonparticipants in the research study who choose to earn a bonus grade will complete the same assignment as the control group.

The description of the two assignments follows:

1. The treatment group using MMT: Students will complete the weekly hours and assessments in an online review of the prerequisite college algebra skills using MMT (see grading rubric at end of syllabus.). In addition to the normal sequence of course homework using MLP, students in the treatment group will be required to spend 3 hours per week for the first 4 weeks of the semester reviewing the prerequisite algebra skills.

An access code will be provided to the students assigned to the MMT review treatment group, which will allow access to the web-based MMT online program from their own personal computer or from a computer in a lab on campus. Upon accessing the program, students will be required to complete an initial MMT assessment that allows the program to identify each student’s skill strengths and weaknesses. Once this has been determined, a study plan presents the students with learning modules in the areas of weakness to study and practice. This should help facilitate the student’s mastery or improved proficiency in those objectives not passed on the initial MMT assessment.

At the end of the four weeks the students will take a final assessment in the MMT program. A grade will be assigned to the students in the MMT review treatment group according to completion of the 3 hour per week time requirement at 19 points possible each week for a total of 76 points and their scores on the initial and the final MMT assessment worth 24% of the grade for a total of 100%.

Mastery level, which ensures students have a command of the prerequisite skills necessary for college algebra, will be set at 100%. Students who achieve mastery level on all areas indicated in the initial assessment before the end of

the first 4 weeks may take the final MMT assessment early. Should the student score 100% on the final assignment before the end of the 4 weeks of the treatment, then the student will receive a bonus grade of 100% and will not be required to continue in the MMT program. At the end of the 4-week period allotted for the skills review, those students still working in the program will take the final MMT assessment. All students in the MMT treatment group will have their access to the MMT program terminated at the end of the 4 weeks.

2. The control group using MLP. Students will complete the extra exercises covering the weekly course content using MLP (see grading rubric at end of syllabus). In addition to the normal sequence of course work using MLP, each week students in this group will be granted access to an extra exercise set of questions covering the content studied that week. Access will begin on Monday and will end at midnight on Sunday. Students will be allowed three attempts at each problem. Any problems not completed by the Sunday deadline will be marked incorrect. There will be no make-ups and no extended deadlines. If all the questions are completed by the deadline then students will be given 19 points each week for their submission for a total of 76 points. The program will check your work for accuracy and give you a grade each of the 4 weeks. The four accuracy grades will be averaged and 24% of that average will be added to the sum of your weekly submission points for a final total of 100 %.

Table D.1

Grade Distribution

Source of grade	%
Ch. 1 test	15%
Ch. 2 test	15%
Ch. 3 test	15%
Final exam	25%
Online graded homework (drop 4)	15%
Lecture class clicker grade (drop 4)	5%
Quizzes (drop 4)	5%
Online worksheets (drop 4)	5%
Total	100%
Bonus grade—may be used to replace lowest test grade	15%

Final Grades: The +/- grading policy will be used in assigning final grades. If your overall percentage of total points falls into the following range, you will receive the corresponding grade:

97-100 (A+), 93-96 (A), 90-92 (A-),
 87-89 (B+), 83-86 (B), 80-82 (B-),
 77-79 (C+), 70-76 (C),
 67-69 (D+), 63-66 (D), 60-62 (D-), 0-59 (F)

Miscellaneous Policies:

- In the event of an emergency, it may be necessary for USF to suspend normal operations. During this time, USF may opt to continue delivery of instruction through methods that include but are not limited to Blackboard, Elluminate, Skype, and e-mail messaging and/or alternate scheduling. It is the responsibility of the student to monitor the main USF website, e-mails, and MoBull messages for important information about the closure. For information about the continuation of instruction, students are directed to their individual Blackboard course sites.
- Cheating will not be tolerated. The university policy on academic dishonesty is explained on the website (<http://www.ugs.usf.edu/catalogs/0708/adadap.htm>).
- Students who must miss a class period due to a major religious observance must notify the instructor of this absence, in writing, by the end of the second week of classes.
- Any student with a disability is encouraged to meet privately with the instructor to discuss accommodations. The student must bring a current memorandum of accommodations from the Office of Student Disability Services (SVC 1133). This memo is a prerequisite for receiving accommodations. All course handouts are

available in alternate format if requested in the student's memorandum of accommodations. Exam accommodations through the Office of Student Disability Services (SDS) require 2 weeks' advance notice. Note: If you need extra time on exams, you *must* make arrangements to take your exams with the SDS office. You *cannot* receive extra time if you choose to take your exams with the course instructor.

- *Please* do not hold conversations, either with your classmates or on your cell phones, during the lecture sessions. (Turn your cell phone off.)
- You are encouraged to take notes and may tape the lectures, but neither your notes nor your tapes are to be sold.
- The last day to withdraw from this course and receive a tuition refund is Friday, Aug. 27 (by 5:00 p.m.).
- The last day to withdraw from this course and receive a grade of W is Saturday, Oct. 30 (by 5:00 p.m.)
- S-U Policy: Students who want to take this course for a grade of S-U must sign the S-U contract no later than the end of the fifth week of classes. There will be no exceptions. For further information on S-U grades, please see the website (<http://www.ugs.usf.edu/catalogs/0708/gradetc.htm>). Note: Gordon rule courses may not be taken on an S-U basis.
- A grade of I indicates incomplete work and will only be assigned when most of the coursework has already been completed with a passing grade. If you are assigned the I grade, then you must sign a written contract with your instructor detailing the dates the work is to be completed. See the website (<http://www.ugs.usf.edu/catalogs/0708/gradetc.htm>) for further information.

Getting Help:

- There is a *Student Solutions Manual* available as a companion to the text. It contains answers to all the odd-numbered problems. There is also a *Study Guide*.
- Additional practice exams in multiple-choice format can be found on the website (<http://mathcenter.usf.edu/>). First, choose College Algebra, then PRACTICE TESTS, and finally MAPLE T.A. INTERACTIVE PRACTICE TEST.
- Arrange to meet your instructor and/or TA outside of class.
- Free math tutoring in the Library—LIB 206
The main phone line: 974-2713 Website: <http://www.usf.edu/learning>

Table D.2

College Algebra Tentative Schedule and Assignments Fall 2010

		Mon./Wed. lecture	Online	Fri. class	Textbk HW (assigned problems below)	
Wk #	Date	Chapter sections to study	Graded HW on MLP due by 11:55pm	Worksheets /quizzes	Discussed, not collected	Assignment for participants in research study
1	23-Aug	Orientation, self-report survey, sign consent, & pretest				Sign consent, survey, & pretest
	25-Aug	Group Assgn Orientation				
	27-Aug			Lecture 1.1	1.1	Wk 1 work for MMT group & control group, due Sun, 8/29
2	30-Aug	1.2				
	1-Sep	1.3, 1.4	1.1, 1.2 due on MLP Sun, 9/5			
	3-Sep			W1 / Q1	1.1, 1.2	Wk 2 work for MMT group & control group, due Sun, 9/5
3	6-Sep	Holiday				
	8-Sep	1.4, 1..5	1.3, 1.4 due on MLP Sun., 9/12			

		Mon./Wed. lecture	Online	Fri. class	Textbk HW (assigned problems below)	
Wk #	Date	Chapter sections to study	Graded HW on MLP due by 11:55pm	Worksheets /quizzes	Discussed, not collected	Assignment for participants in research study
	10-Sep			W2 / Q2	1.3, 1.4	Wk 3 work for MMT group & control group, due Sun., 9/12
4	13-Sep	1.5, 1.6				
	15-Sep	1.6, 1.7	1.5, 1.6 due on MLP Sun., 9/19			
	17-Sep			W3 / Q3	1.5, 1.6	Wk 4 work for MMT group & control group, due Sun., 9/19
5	20-Sep	Posttest				Posttest
	22-Sep	1.7				
	24-Sep		1.7 due on MLP Sun., 9/26	W4 / Q4	1.7	
6	27-Sep	Review	Review due on MLP Tues., 9/28			
	29-Sep	Chapter 1 test				
	1-Oct			W-correct Test 1		
7	4-Oct	2.1				
	6-Oct	2.2				

		Mon./Wed. lecture	Online	Fri. class	Textbk HW (assigned problems below)	
Wk #	Date	Chapter sections to study	Graded HW on MLP due by 11:55pm	Worksheets /quizzes	Discussed, not collected	Assignment for participants in research study
	8-Oct		2.1, 2.2 due on MLP Sun., 10/10	W5 / Q5	2.1, 2.2	
8	11-Oct	2.3				
	13-Oct	2.5				
	15-Oct		2.3, 2.5 due on MLP Sun., 10/17	W6 / Q6	2.3, 2.5	
9	18-Oct	2.6				
	20-Oct	Review				
	22-Oct		2.6 & online review due on MLP Sun., 10/24	W7 / Q7	2.6	
*10	25-Oct	Chapter 2 test				
	27-Oct	3.1				
	29-Oct			W-correct Test 2	3.1	
11	1-Nov	3.2				
	3-Nov	3.3				
	5-Nov		3.1, 3.2 due on MLP Sun., 11/7	W8 / Q8	3.1, 3.2	
12	8-Nov	3.4				
	10-Nov					
	12-Nov		3.3, 3.4 due on MLP Sun., 11/14	W9 / Q9	3.3, 3.4	

		Mon./Wed. lecture	Online	Fri. class	Textbk HW (assigned problems below)	
Wk #	Date	Chapter sections to study	Graded HW on MLP due by 11:55pm	Worksheets /quizzes	Discussed, not collected	Assignment for participants in research study
13	15-Nov	3.5				
	17-Nov	Review				
	19-Nov		3.5 & online review due on MLP Sun. 11/21	W10 / Q10	3.5	
14	22-Nov	Chapter 3 test				
	24-Nov	7.1 (online; campus attendance not required)	7.1 due on MLP Sun., 11/28		7.1	
	26-Nov	Holiday				
15	29-Nov	7.4	7.4 due on MLP Wed., 12/1		7.4	
	1-Dec	Practice final exam				
	3-Dec			Review		Final exam Mon., Dec. 6 3:00 p.m., Room TBA
*Oct. 30-	Last day to withdraw					

SUGGESTED TEXTBOOK HOMEWORK:

The following are some typical problems sorted by section. Note that you should do a lot more than what is suggested here in order to get a better understanding of the material.

Chapter 1—Graphs & Functions

Section 1: pp. 13-15: 2, 3, 11, 13, 16, 17, 21, 27, 35, 39, 43, 51, 61, 63, 67, 71, 73, 84

Section 2: pp. 26-28: 1, 9, 17, 19, 21, 29, 35, 37, 39, 45, 47, 53, 71, 73, 91

Section 3: pp. 43-45: 3, 11, 13, 17, 20, 25, 33, 39, 43, 45, 53, 57, 61, 63, 69, 83
 Section 4: pp. 58-60: 1, 5, 11, 17, 23, 29, 35, 43, 47, 51, 55, 65
 Section 5: pp. 74-76: 1, 7, 11, 16, 17, 21, 25, 29, 33, 39, 57, 63, 65, 67, 71, 73, 77, 85
 Section 6: pp. 84-85: 1, 8, 9, 13, 15, 19, 21, 23, 31, 35, 37, 41, 45, 49, 53, 59, 65
 Section 7: pp. 96-98: 3, 7, 9, 15, 17, 27, 29, 33, 37, 41, 49, 51, 55, 61, 65, 67
 Practice tests A & B: pp. 104-106

Chapter 2—Polynomial & Rational Functions

Section 1: pp. 114-116: 4, 13, 15, 17, 25, 33, 35, 39, 41, 43, 49, 55, 59, 61, 65, 69
 Section 2: pp. 130-132: 1, 9, 11, 17, 18, 25, 27, 29, 33, 35, 39, 41, 53, 65, 73
 Section 3: pp. 142-143: 1, 9, 13, 17, 21, 25, 31, 33, 39, 43, 47, 64
 Section 5: pp. 166-169: 5, 6, 7, 13, 19, 23, 25, 31, 35, 37, 41, 43, 49, 53, 57, 65, 73, 81
 Section 6: pp. 177-179: 5, 9, 11, 13, 15, 17, 19, 33, 35, 37, 39
 Practice tests A & B: pp. 185-187

Chapter 3—Exponential & Logarithmic Functions

Section 1: pp. 197-198: 3, 7, 17, 21, 25, 31, 33, 37, 43, 45, 49, 57, 65, 73, 75, 87
 Section 2: pp. 208-209: 3, 7, 9, 13, 15, 17, 19, 23, 25, 27, 33, 35, 39
 Section 3: pp. 222-224: 3, 7, 11, 15, 19, 23, 27, 31, 35, 43, 45, 47, 53, 57, 61, 63, 71, 75, 81, 85, 89, 91, 95, 97
 Section 4: pp. 232-233: 1, 3, 7, 11, 15, 19, 25, 27, 31, 35, 37, 43, 51, 57, 61, 63, 73
 Section 5: pp. 243-244: 1, 2, 9, 15, 17, 19, 23, 25, 31, 39, 41, 53, 59, 63, 65, 69, 73
 Practice tests A & B: pp. 250-251

Chapter 7—Systems of Equations & Inequalities

Section 1: pp. 489-491: 3, 7, 11, 13, 17, 25, 29, 37, 41, 47, 55, 57, 59, 81, 89, 93
 Section 3: pp. 513-514: 1, 7, 11, 15, 23, 29, 33, 39

Table D.3

Grading Rubric for MMT Treatment Group Bonus Grade

	Points awarded for MMT initial assessment	Points awarded for weekly time requirement	Points awarded for MMT final assessment	Final MMT review treatment grade
	4		20	
Week 1		19		
Week 2		19		

Week 3		19			
Week 4		19			
Total	4	76	20	100%	
	3 Hrs. min. required weekly with points awarded as follows:		Points for MMT initial & final assessment will be awarded as follows:		
Weekly hrs.	Point value		4% of MMT initial assessment score		
3 hrs or more	19		20% of MMT final assessment score		
$1 \leq \text{hrs.} < 3$	9				
$0 \leq \text{hrs.} < 1$	0				
			Note: 2.99 hrs. will be 9 points		

Table D.4

Grading Rubric for MLP Control Group Bonus Grade

	Points awarded for weekly submission of all questions on the extra exercise sets	Points awarded for average of the 4 sets of extra exercises grade	Final control group bonus grade
Week 1	19		
Week 2	19		
Week 3	19		
Week 4	19		
Total	76	24	100%

Points for average of extra exercise sets will be awarded as follows: 24% of the average of the four grades for the exercise sets. All questions in each of the four sets submitted weekly with points awarded as follows:

Table D.5

Point Value of Extra Exercise Questions

Weekly questions completed	Point value
All questions completed	19
½ of the questions	9
Less than ½	0

Appendix E: Informed Consent Form



Informed Consent to Participate in Research

Information to Consider Before Taking Part in this Research Study

IRB Study # _____

108222

Welcome to College Algebra. The University of South Florida is among the top 63 public research universities in the country. Some of that research is directed toward improving curriculum and instruction that can better prepare students for their educational journey.

This semester a study will be conducted in your college algebra class and you are invited to voluntarily take part. It is titled, "A Comparative Study of Two Short-term Remediation Approaches Within a College Algebra Course on Student Achievement." This study will be under the direction of your instructor, Frances Hopf, as principle investigator. However, other research staff may be involved and can act on her behalf.

The **purpose** of this study is to assess if completing one of two possible short-term online remediation programs at the start of a college algebra course will increase students' success in the course compared to students who do not complete an online remedial program. It will also investigate whether gender, high school math GPA, highest high school math course taken and passed, time elapsed since the last math course was taken, or whether this is the student's first attempt at college algebra will have an interaction effect with the remediation approaches and success in the college algebra course.

As part of the grade requirement for this course all students in this college algebra class will be expected to complete one of three assignments associated with this study during the first four weeks of the semester along with the normal sequence of course topic assignments. This part of the grade requirement will count 15% your final course grade. However, if you agree to take part in this study then

the data obtained from this part of the grade requirement will be used in the research analysis. As a participant in the study you will be asked to do the following.

- **Accept a random assignment** to one of three groups. Two of the groups will work on two options of online remediation programs. The third group will not have any remediation but will have a written assignment that will include library research, writing, and an interview designed to take an equivalent amount of student time.
- **Begin the study with a pre-test** given on the second day of class and end four weeks later with a **post-test**.
- **Spend a minimum of 6 hours or more each of the four weeks** on the work associated with your random group assignment.
- **Use your computer** or one of the computers on campus to complete the work associated with your random group assignment.

You have the **alternative to choose not to participate in this research study**. If you choose not to participate in this research study you will be given the same assignment as the third group in the study that will be doing the assignment which will include library research, writing, and an interview designed to take an equivalent amount of student time. This will count 15% of your final course grade.

This research is considered to have **minimal risk**. Any possible unanticipated risks that might be associated with participation in this study are equivalent to any unanticipated risks that could be normally associated with enrolling in USF's College Algebra course. There is no monetary compensation for volunteering to be a participant in this study.



1

Benefits to being in this study include the potential instructional benefits that may come from completing the group assignments associated with this study.

Your **study records will be kept as confidential as possible**. You will be assigned an identification code using a letter and a number. All personal data will be stored using that identification code. However, certain people may need to see your study records. By law, anyone who looks at your records must keep them completely confidential. The only people who will be allowed to see these records are the research team and other research staff. Also, certain government and university people may need to know more about the study. For example, individuals who provide oversight on this study may need to look at your records. This is done to make sure that we are doing the study in the right way. They also need to make sure that we are protecting your rights and your safety. This includes the University of South Florida Institutional Review Board (IRB) and the staff that work for the IRB and the Department of Health and Human Services (DHHS). Other individuals who work for USF that provide other kinds of oversight may also need to look at your records. We may publish what we learn from this study. If we do, we will not let anyone know your name. We will not publish anything else that would let people know who you are.

You should only take part in this study if you want to **volunteer**. You should not feel that there is any pressure to take part in the study to please the instructor or the research staff. You are free to participate in this research or **withdraw at any time**. There will be no penalty or loss of benefits you are entitled to receive if you stop taking part in this study. Your decision to participate or not to participate will not affect your course grade providing you fulfill the grading requirements of the course syllabus.

If you have any **questions, concerns or complaints about this study**, call Fran Hopf at 813-404-3035. If you have questions about your rights as a participant in this study, general questions, or have complaints, concerns or issues you want to discuss with someone outside the research, call the Division of Research Integrity and Compliance of the University of South Florida at (813) 974-9343.

Consent to Take Part in this Research Study

It is up to you to decide whether you want to take part in this study. If you want to take part, please sign the form, if the following statements are true.

I freely give my consent to take part in this study. I understand that by signing this form I am agreeing to take part in research. I have received a copy of this form to take with me.

Signature of Person Taking Part in Study

Date

Printed Name of Person Taking Part in Study

Statement of Person Obtaining Informed Consent

I have carefully explained to the person taking part in the study what he or she can expect.

I hereby certify that when this person signs this form, to the best of my knowledge, he or she understands:

- What the study is about.
- What procedures/interventions/investigational drugs or devices will be used.
- What the potential benefits might be.
- What the known risks might be.

Signature of Person Obtaining Informed Consent

Date

Printed Name of Person Obtaining Informed Consent



2

Appendix F: Self-Report Survey

If you signed the consent form to be a part of this math research study, then please complete this survey. Using the Scantron, bubble your name and ID number in the locations indicated, and then bubble the letters that best answer the questions. All responses will be kept confidential.

1. What is your gender?
 - A. Male
 - B. Female
2. Is this your first attempt at taking college algebra?
 - A. Yes
 - B. No

Appendix G: Sample Pretest/Posttest of Prerequisite College Algebra Skills

1. Find the value of the expression.

$$\frac{6(2+1) - 6(1+1)}{6(4-2) - 2^3}$$

A. $\frac{3}{2}$

B. 3

C. $\frac{3}{5}$

D. $\frac{3}{4}$

2. Evaluate the expression, given $x = -2$, $y = 3$, and $a = -4$.

$$\frac{5a^2 - y}{x + 2}$$

A. $\frac{77}{4}$

B. Undefined

C. $-\frac{83}{4}$

D. 0

3. Solve the equation.

$$-5(3x - 4) = 9(x + 2) + 2 - 24x$$

A. 0

B. All real numbers

C. No solution

D. 40

4. Choose the equation that is equivalent to the verbal description:
The difference between a number, x , and five less than twice the number is 2.

A. $x - (5 - 2x) = 2$

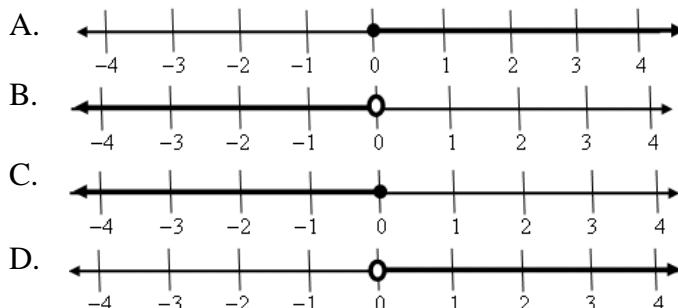
B. $x - 2x - 5 = 2$

C. $x - (2x - 5) = 2$

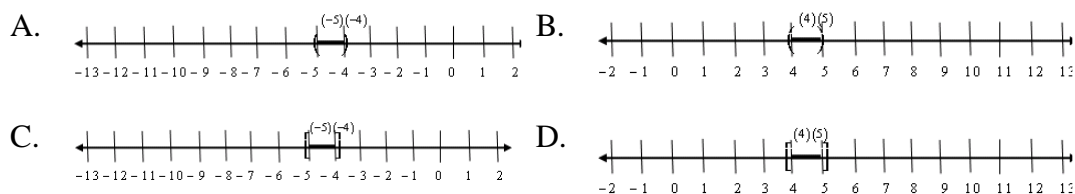
D. $x + (5 - 2x) = 2$

5. Solve the inequality and graph the solution.
 $-9 - 8m - m < 3m - 9$ What is the solution?

Choose the correct graph below.



6. Solve the compound inequality. Graph the solution set.
 $-13 \leq -2z - 3 \leq -11$



7. Solve the compound inequality.
 $x \leq 3$ or $x \geq 6$

- A. $[-6, -3]$
 B. $(-\infty, 3] \cup [6, \infty)$
 C. $(3, 6)$
 D. $(-3, 6)$

8. Solve the absolute value equation.

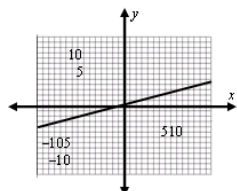
$$|x - 8| = 5$$

- A. 3, 13
 B. -3, 13
 C. -13
 D. \emptyset

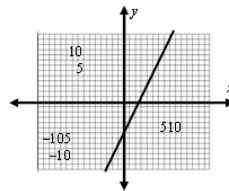
9. Complete the ordered pairs. Then graph the equation by plotting the points and drawing a line through them.

$$x = 3y - 8 \quad \left(\quad, 0 \right), \quad \left(0, \quad \right), \quad \left(\quad, \frac{1}{3} \right)$$

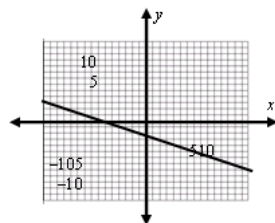
A. $(0, 0), (0, 0), \left(1, \frac{1}{3} \right)$



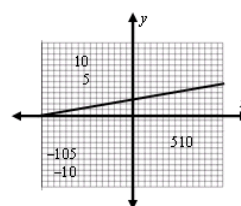
B. $\left(\frac{8}{3}, 0 \right), (0, -8), \left(\frac{25}{9}, \frac{1}{3} \right)$



C. $(-8, 0), \left(0, -\frac{8}{3} \right), \left(-9, \frac{1}{3} \right)$

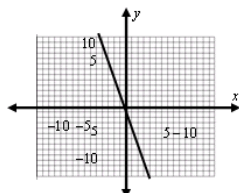


D. $(-8, 0), \left(0, \frac{8}{3} \right), \left(-7, \frac{1}{3} \right)$

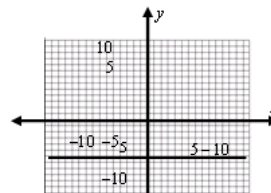


10. Graph the linear equation.
 $y + 5 = 0$

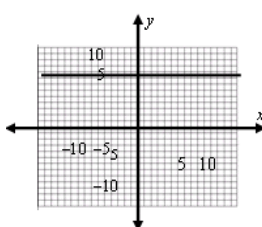
A.



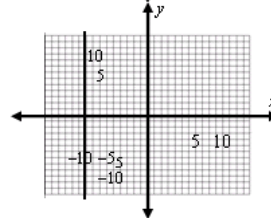
B.



C.



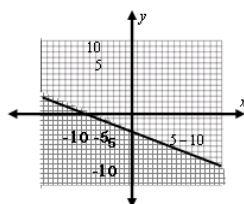
D.



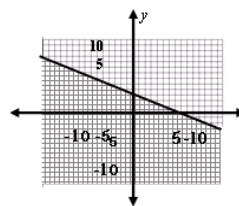
11. Graph the linear equality.

$$-4y \leq 2x - 8$$

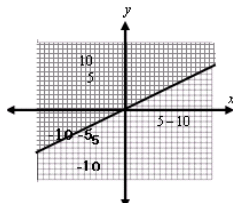
A.



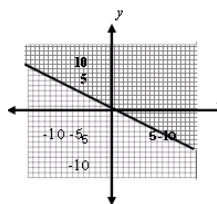
B.



C.



D.



12. Perform the indicated operation.

$$(-4x^4 + 9x^6 + 2 - 2x^5) - (-8 + 4x^5 + 5x^6 - 7x^4)$$

- A. $4x^6 + 2x^5 - 11x^4 - 6$
 B. $14x^6 + 2x^5 - 11x^4 - 6$
 C. $14x^6 + 2x^5 - 11x^4 + 10$
 D. $4x^6 - 6x^5 + 3x^4 + 10$

13. Simplify the expression. Use positive exponents. Assume variables represent nonzero numbers.

$$\left(\frac{4p^2v^3}{s^3} \right)^3$$

- A. $\frac{64p^5v^6}{s^6}$
 B. $\frac{4p^6v^9}{s^9}$
 C. $\frac{64p^6v^9}{s^9}$
 D. $\frac{4p^6v^9}{s^6}$

14. Find the product.
 $3y^3(2y-2)(y+3)$
- A. $6y^5 + 12y^4 - 18y^3$
B. $18y^4 - 18y^3$
C. $6y^5 - 18y^3$
D. $12y^4 - 18y^3$
15. Find the square.
 $(7a-1)^2$
- A. $49a^2 + 1$
B. $49a^2 - 14a + 1$
C. $7a^2 + 1$
D. $7a^2 - 14a + 1$
16. Evaluate the exponential expression $16b^0$, if $b \neq 0$.
- A. 0
B. $16b$
C. 1
D. 16
17. Perform the division.
$$\frac{2y^2 + 12y - 32}{y + 8}$$
- A. $2y - 8$
B. $2y + 4$
C. $2y - 4$
D. $y - 4$
18. Factor. $7a^2(3a+4) - 6(3a+4)$
- A. $(7a^2 + 6)(3a + 4)$
B. $(7a^2 - 6)(3a + 4)$
C. $7a^2(3a + 4)$
D. $(7a^2 - 6)(3a + 4)^2$

19. Which of the following is a factor of $x^2 - 7x - 8$?
- A. $(x - 1)$
 - B. $(x - 8)$
 - C. $(x - 2)$
 - D. $(x - 4)$
 - E. $(x + 2)$
20. Say the answer in the back of the book is $-(x + 5)(x - 5)$. Is $(x + 5)(5 - x)$ also correct?
- A. No.
 - B. Yes.
21. Which of the following is a linear factor of $2x^2 + x - 10$?
- A. $x + 2$
 - B. $x - 5$
 - C. $2x - 5$
 - D. $2x + 5$
22. Solve the equation.
 $x(3x + 15) = 0$
- A. 0, -5
 - B. 0, $\frac{1}{5}$
 - C. 0, 5
 - D. 0, $-\frac{1}{5}$
23. Solve the equation.
 $x^2 - x = 56$
- A. 7, 8
 - B. -7, -8
 - C. 1, 56
 - D. -7, 8

24. Find any values for which the rational expression is undefined.

$$\frac{2x+3}{x^2-3x-10}$$

- A. $-5, 2$
B. 5
C. The expression is never undefined.
D. $5, -2$

25. Divide. Write the answer in lowest terms.

$$\frac{4x-4y}{80-10z} \div \frac{2y-2x}{z-8}$$

- A. $\frac{1}{40}$
B. $\frac{2(x-y)}{10}$
C. $\frac{1}{5}$
D. $-\frac{1}{5}$

26. Add. Express your answer in lowest terms.

$$\frac{x+4}{5x} + \frac{8x+4}{2x}$$

- A. $\frac{42x+28}{10x}$ B. $\frac{21x+14}{5x}$ C. $\frac{9x+8}{7x}$ D. $\frac{21x+28}{10x}$

27. Simplify the complex fraction.

$$\frac{\frac{x^9}{3y^7}}{\frac{x^7}{y^5}}$$

- A. $\frac{x^2}{3y^{12}}$
B. $\frac{x^{16}}{3y^{12}}$
C. $\frac{x^2}{y^2}$
D. $\frac{x^2}{3y^2}$

28. Solve the equation and check your answer.

$$\frac{6x}{49x+45} = \frac{1}{x}$$

A. $-\frac{5}{6}, 9$

B. $\frac{45}{54}$

C. $\frac{5}{6}, -9$

D. No solution

29. Classify the square root as rational, irrational, or not a real number.

$$\sqrt{-19}$$

A. Irrational

B. Not a real number

C. Rational

30. Find the square of the radical expression.

$$\sqrt{4x^2 + 25}$$

A. $4x + 5$

B. $4x^2 + 25$

C. $2x + 5$

D. $4x + 25$

31. Simplify the radical.

$$2\sqrt{19}$$

A. 8

B. $19\sqrt{2}$

C. $2\sqrt{19}$

D. 38

32. Find the product and simplify.

$$\sqrt{11} \cdot \sqrt{11}$$

A. $\sqrt{121}$

B. 11

C. $\sqrt{22}$

D. $\sqrt{11}$

33. Rationalize the denominator.

$$\sqrt{\frac{2}{7}}$$

A. $\frac{\sqrt{14}}{\sqrt{7}}$

B. $\frac{\sqrt{14}}{49}$

C. $\frac{\sqrt{14}}{7}$

D. $\frac{\sqrt{9}}{7}$

34. Simplify.

$$(9 - \sqrt{11})^2$$

A. $92 - 18\sqrt{11}$

B. $92 + 18\sqrt{11}$

C. $91 + \sqrt{11}$

D. $81 + \sqrt{11}$

35. Use radical notation to write the expression. Simplify if possible.

$$6x^{2/5}$$

A. $6\sqrt[5]{x^2}$

B. $\sqrt[2]{6x^5}$

C. $\sqrt[5]{6x^2}$

D. $\sqrt[5]{36x^2}$

Appendix H: Skills Necessary for College Algebra

The following skills were determined, based on a survey conducted by the Florida Department of Education for academic year 2008-2009 (Florida Department of Education, n.d.) to be necessary for college algebra.

Benchmark	Avg	AvgDev	Responses	% Scoring 2+
1. Understand the properties of integer exponents and roots and apply these properties to simplify algebraic expressions.	2.64	0.46	11	100%
2. Understand the properties of rational exponents and apply these properties to simplify algebraic expressions.	2.36	0.69	9	82%
3. Add, subtract, and multiply polynomials;	2.91	0.17	11	100%
4. Factor polynomials by removing the greatest common factor; factor quadratic polynomials.	2.64	0.53	10	91%
5. Add and subtract rational expressions.	2.55	0.58	10	91%
6. Multiply, divide, and simplify rational expressions.	2.73	0.40	11	100%
7. Evaluate polynomial and rational expressions and expressions containing radicals and absolute values at specified values of their variables.	2.82	0.30	11	100%
8. Solve linear equations and inequalities in one variable including those involving the absolute value of a linear function.	2.64	0.53	10	91%
9. Solve an equation involving several variables for one variable in terms of the others.	2.45	0.60	10	91%
10. Solve quadratic equations in one variable—by factoring	2.55	0.66	9	82%

Appendix I: Pretest-Posttest Reliability Report

Pretest-Posttest Reliability Statistical Report February 12, 2010	
Item	Overall
Score data	
Number of graded items	35
Total points possible	35
Maximum score	32
Minimum score	6
Statistics	
Mean score	21.45
Mean percent score	61.28
Benchmark score	
Range of scores	26
Standard deviation	5.22
Variance	27.28
Percentiles	
Percentile (25)	18
Median score	22
Percentile (75)	26
Inter quartile range	8
Test reliability	
Kuder-Richardson formula 20	0.77
Kuder-Richardson formula 21	0.72
Coefficient (Cronbach) alpha	0.77

Appendix J: Departmental Final Exam Reliability Report

Departmental Final Exam Reliability Statistical Report May 4, 2010	
Item	Overall
Score data	
Number of graded items	40
Total points possible	40
Maximum score	36
Minimum score	4
Statistics	
Mean score	20.64
Mean percent score	51.59
Benchmark score	
Range of scores	32
Standard deviation	6.42
Variance	41.18
Percentiles	
Percentile (25)	16
Median score	21
Percentile (75)	25
Inter quartile range	9
Test reliability	
Kuder-Richardson formula 20	0.81
Kuder-Richardson formula 21	0.78
Coefficient (Cronbach) alpha	0.81